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THE INFLUENCE OF MISLEADING POSTEVENT INFORMATION ON ITEM RECOGNITION

ROBERT F. BELL

University of New Hampshire, Durham

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**The influence of misleading postevent information on item
recognition**

Belli, Robert F., Ph.D.

University of New Hampshire, 1987

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THE INFLUENCE OF
MISLEADING POSTEVENT INFORMATION
ON ITEM RECOGNITION

BY

ROBERT F. BELL
B.A., University of Notre Dame, 1977
M.A., State University of New York at Geneseo, 1983

DISSERTATION

Submitted to the University of New Hampshire
in Partial Fulfillment of
the Requirements for the Degree of

Doctor of Philosophy

in

Psychology

September, 1987

This dissertation has been examined and approved.

Victor A. Benassi

Dissertation director,
Victor A. Benassi,
Associate Professor of Psychology

John Limber

John Limber,
Associate Professor of Psychology

Albrecht W. Inhoff

Albrecht W. Inhoff,
Assistant Professor of Psychology

Grant Cioffi

Grant Cioffi,
Associate Professor of Education

R. Valentine Dusek

R. Valentine Dusek,
Associate Professor of Philosophy

8/6/87
Date

To my families, my friends, my colleagues,
and numerous others whom I have read but never met,
for helping me, in their unique ways, to understand
that there are achievements that can be attained.

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TABLE OF CONTENTS

DEDICATION.....	iii
ACKNOWLEDGEMENTS.....	iv
TABLE OF CONTENTS.....	v
LIST OF TABLES.....	vii
ABSTRACT.....	ix
CHAPTER	PAGE
I. POSTEVENT INFORMATION AND REMEMBERING.....	1
Historical Influences on Postevent Information Studies.....	3
Literature on Memory for Form.....	3
Literature in the Psychology of Testimony.....	11
Recent Postevent Information Studies.....	14
Initial Studies and Considerations.....	14
The Substitution and Coexistence Hypotheses.....	26
The No Effect Hypothesis.....	35
Rationale for the Current Experimental Investigation.....	50
The Retrieval Test.....	50
Implications for Eyewitness Testimony.....	57
Chapter Note.....	61
II. THE EXPERIMENTAL INVESTIGATION.....	62
Method.....	62
Subjects.....	62
Procedure.....	62

Results and Discussion.....	66
Subjects Analyses.....	67
Items Analyses.....	69
Chapter Notes.....	83
III. CONCLUSIONS.....	87
The Memory Impairment Issue.....	88
Implications for Eyewitness Testimony.....	91
LIST OF REFERENCES.....	107

LIST OF TABLES

TABLE	PAGE
Table 1 Hypothetical Response Pattern of Saying Yes to Event Item....	94
Table 2 Hypothetical Response Pattern of Saying No to Novel Item.....	95
Table 3 Algebraic Proof that any Values can be Assigned Without Affecting Critical Comparison.....	96
Table 4 Summary of Postevent Information Condition X Recognition Test Condition Subjects Analysis of Variance on the Combination Scores.....	97
Table 5 Summary of Postevent Information Condition X Recognition Test Condition Items Analysis of Variance on the Accuracy Scores.....	98
Table 6 The Correct Number of Accuracy Scores for Better Remembered and Poorly Remembered Items.....	99
Table 7 Number and Percentages of Correct Rejections in Response to Better Remembered and Poorly Remembered Items Shown in the Event and the Better Remembered and Poorly Remembered Items Items Used as Novel Items Test Distractors for the Control--Novel Items Test Condition.....	100
Table 8 Summary of Postevent Information Condition X Recognition Test Condition Analysis of Variance on the Accuracy Scores with Better Remembered Items.....	102
Table 9 Summary of Postevent Information Condition X Recognition Test Condition Analysis of Variance on the Accuracy Scores with Poorly Remembered Items.....	103
Table 10 The Mean Combination Scores for Better Remembered and Poorly Remembered Items.....	104

Table 11	
Summary of Postevent Information Condition X Recognition	
Test Condition Analysis of Variance on the Mean Combination	
Scores with Better Remembered Items.....	105
Table 12	
Summary of Postevent Information Condition X Recognition	
Test Condition Analysis of Variance on the Mean Combination	
Scores with Poorly Remembered Items.....	106

ABSTRACT

THE INFLUENCE OF MISLEADING POSTEVENT INFORMATION ON ITEM RECOGNITION

by

Robert F. Belli
University of New Hampshire, September, 1987

This investigation has sought to evaluate two disputed issues regarding experimental research on the influence of misleading postevent information on the remembering of originally experienced event information: 1) whether misinformation leads to memory impairment, and 2) whether experimental findings are generalizable to real world eyewitnesses.

Subjects were shown four critical event items in a series of slides. Afterward, all subjects were misinformed (misled condition) that for two of the event items, other items had appeared. No misinformation (control condition) was provided for the remaining two event items. Subjects made separate yes/no verbal recognitions on the original appearance of event items and novel items (items neither shown nor presented as misinformation). Assignments were counterbalanced.

The yes/no procedure tested the respective roles of two hypothesized processes. The coexistence hypothesis asserts that misleading postevent information leads to an impairment in the ability to access original event information. According to the no effect

hypothesis, misleading postevent information only affects the responses of subjects who would ordinarily not remember the event information. Evidence for memory impairment arises if there are significantly more correct responses with the control versus misled conditions. If misinformation influences responses when the event information is not remembered, then, with event items tests, decreases in correct responses for the misled condition in comparison to the control condition will be matched by equivalent increases, with novel items tests, in correct responses for the misled versus control conditions.

Results are inconclusive with respect to memory impairment. Although responses were not significantly more often correct with control versus misled conditions, there was some indication that the misinformation led to a poorer ability to discriminate event from novel items. Results were conclusive that the misinformation influenced responses when the event information was not remembered. With event items tests, control performance reliably exceeded misled performance; with novel items tests, misled condition responses were significantly more often correct than control condition responses.

Results demonstrate that response accuracy depends on particular conditions. General statements regarding the response accuracy of real world eyewitnesses exposed to misinformation are unwarranted. Statements should be based on knowledge of specific circumstances.

CHAPTER I

POSTEVENT INFORMATION AND REMEMBERING

In numerous studies, Elizabeth Loftus and her associates (e.g., Loftus 1975, 1977, 1979a; Loftus, Miller, & Burns, 1978; Loftus & Palmer, 1974; Loftus & Zanni, 1975) have demonstrated that misleading postevent information, that is, information introduced to subjects after witnessing an event, will lead to distortions during retrieval of what had been seen. Loftus and associates have argued that their studies support the notion that the introduction of misleading postevent information alters the original memorial representation of the witnessed event (see also Loftus & Loftus, 1980; Loftus, Schooler, & Wagenaar, 1985). In addition, they have suggested that their research implies that real world eyewitnesses who experience (mis)leading information will provide unreliable and inaccurate testimony.

Recently, McCloskey and Zaragoza (1985a, 1985b) have challenged the conclusions of Loftus and associates. McCloskey and Zaragoza have demonstrated in the laboratory that misleading postevent information will not always lead to distorted retrievals. Through argument and evidence, they have provided substantive doubt that the introduction of postevent information results in memory alteration. Instead, they attribute the distorted retrievals of misled subjects in postevent

information studies as the result of the misleading information simply biasing subjects' responses. In addition, they question whether any implications ought to be drawn from postevent studies to actual eyewitness testimony, given that even in the laboratory "subjects' responses are not always affected by misleading information" (1985b, p. 386).

The current investigation seeks to clarify 1) whether misleading postevent information alters the memorial representation of events, and 2) the implications of postevent information studies with respect to eyewitness testimony. In the literature review that follows, the influence of misleading postevent information on retrieval is well documented, and competing hypotheses with respect to influences on memory representations are entertained. I suggest that McCloskey and Zaragoza (1985a) provide inadequate evidence that misleading postevent information does not affect memory, largely on the basis that their memory retrieval test may have been insensitive to potential influences, and a more sensitive test for memory alteration is conducted. Unfortunately, results will be shown to be inconclusive with respect to any influences of misleading postevent information on memory. Concerning the issue of the implications of postevent information studies, I will conclude that there are severe limitations on generalizing from the responses of participants in the laboratory to real world eyewitnesses. Even if misleading postevent information alters memory, generalization is difficult because retrievals of misled individuals may be either more or less accurate dependent on the conditions of retrieval.

Historical Influences on Postevent Information Studies

The most active researcher studying the influence of postevent information on remembering in recent years has clearly been Elizabeth Loftus. The studies by Loftus and associates during the mid to late 1970s has stimulated a great deal of interest in the notion of memory change (e.g., Loftus, 1975, 1977, 1979a; Loftus et al., 1978; Loftus and Palmer, 1974; Loftus & Zanni, 1975). These studies, taken together, have been offered as evidence that memories for past events can be altered by information that occurs subsequently (i.e., postevent information) to witnessing the event.

Loftus and her associates were not the first psychologists to argue for the existence of alteration in the content of memories. They considered their work to be an extension of earlier research. In particular, there are citations to two sources of literature: 1) the "memory for form" literature (for reviews see Riley, 1966; Woodworth, 1938), a tradition of studies that has been active until quite recent times (e.g., Daniel, 1972), and 2) the "psychology of testimony" literature which was conducted in the first quarter of the 1900s.

Literature on Memory for Form

Research on memory for form can be traced to the turn of the century (e.g., Baldwin & Shaw, 1895; Philippe, 1897). From the start, this research tradition and hypotheses concerning alteration in memory have gone hand in hand. As suggested by the term "form," much of the research focused on the use of drawings, pictures, photographs, or objects as the stimuli to be remembered. In a typical study,

participants would receive a single exposure to the forms to be remembered, and later would be asked to recall the forms they had seen either verbally or in drawings on one or more occasions. In the recalls, deviations from the originals were noted. Researchers often drew inferences that the deviations in recalls were reflections of alterations that had occurred in the memorial representations themselves.

The putative alterations in memories were seen by the memory for form researchers as involving additional processes than aspects of forgetting attributed to fading, decay, or the loss of distinctiveness of the memory trace over time. In perhaps the first studies performed on memory for form, Baldwin and Shaw (1895) and Warren and Shaw (1895) discovered evidence that the memories of squares will grow larger over time.[1] According to Warren and Shaw, they had shown

that besides the growth of inaccuracy, or indistinctiveness, of the memory-image, there is another factor at work, by which the memory-image tends to grow larger as the time interval increases. (p. 241, emphasis in the original)

Influenced by the findings of Warren and Shaw (1895), Kennedy (1898) argued that alterations in memory could only be demonstrated if one was to investigate distortions in the content of the materials to be remembered. Kennedy reasoned that studies such as Ebbinghaus's (1885/1964), which used lists of relatively unrelated syllables, had "treated memory as a function which operates according to formal laws independent of the content to be remembered" (Kennedy, p. 483). Such studies could only measure loss of distinctiveness of memories as a

product of retention intervals. In Kennedy's view, studying changes associated with the remembering of the content of the material was necessary in order to gain knowledge of all the processes of forgetting.

One of the most common findings of the memory for form researchers is that the content of memories alters in the direction of becoming consistent with one's prior knowledge (Bartlett, 1932; Crosland, 1921; Kuhlmann, 1906, 1907; Philippe, 1897). Prior knowledge supplies the material a holistic "dominant meaning," and during remembering, distortions in detail occur as inferences about what must have been experienced are drawn based on the dominant meaning. These inferences were not seen as maintaining some distinction apart from "intact" memory traces, but were viewed as becoming integrated into a memory representation of the form. Frequently, representations were spoken of being "constructed" and "reconstructed" (Bartlett, 1932; Crosland, 1921; Kuhlmann, 1907), maintaining some similarity to the original form, but also reflecting elaborations in an "effort after meaning" (Bartlett, 1932, p. 84).

The work of Bartlett (1932) provides a theoretical justification for alteration in memory. According to Bartlett, "in a world of constantly changing environment, literal recall is extraordinarily unimportant" (p. 204). Accurate reproduction of the past requires the storage of traces "of individual and specific events" (p. 197). For accuracy in memory to be the norm, "every normal individual must carry about with him an incalculable number of individual traces" (p.197). Such a storage would be a hindrance in a world of change, and

impossible for an organism of finite capacities to maintain. For Bartlett (1932), people do not form individual traces of experiences for the purposes of accuracy, but they actively make experiences meaningful for the purpose of adapting to the environs. The ability to adapt involves the development of a generalized orientation to the world which provides a meaningful framework for interpreting events.

The view that people actively engage in organizing material into a meaningful framework leads directly to Bartlett's concept of 'schema.' For Bartlett, schemata not only represent past experience, but they are "living, constantly developing,...[as] active organisation[s] of past reactions,...which must always be supposed to be operating in any well-adapted organic response" (p. 200, 201). Thus, schemata provide the ability to adapt to constantly changing environs. Bartlett recognized two processes by which schemata aid in adaptation: 1) a schema assimilates events so that new experiences are seen to be consistent with past experience, and 2) a schema accommodates to events so as to be continually relevant to current situations (Belli, 1986; Spiro, 1980). For Bartlett, a permanent memory is completely unadaptive. We construct the present and reconstruct the past, and by so doing, the changing nature of our memories adapts to our changing world.

Beyond Bartlett's (1932) theoretical justification for the existence of alteration in the content of memories, the notion of memory change received substantial empirical support as well. In a landmark study that is still cited (e.g., Bransford, 1979; Bower, Karlin, & Dueck, 1975; Daniel, 1972; Loftus et al, 1978; McCloskey &

Zaragoza, 1985a) as evidence in support of the existence of memory change, Carmichael, Hogan, and Walter (1932) provided one of the earliest experimental demonstrations of alteration in memory.

Carmichael et al. (1932) presented to subjects a series "of twelve relatively ambiguous figures" (p. 74). In addition, two series of word lists were paired with the figures. The two word series each contained 12 words or phrases, each word or phrase reasonably suggesting a label for one of the forms. Upon presenting the forms, subjects were told that each figure resembled a figure or object denoted by a label from either of the two series. As an example, one of the figures was said to resemble a "crescent moon" with one of the series of word lists, and the same figure was labelled as a "letter C" with the other word list. One of the series of word lists was paired with the forms upon presentation to 48 subjects, the other word list was presented to 38 subjects, and a control group of 9 subjects, who were not exposed to any labels, was also used.

Two of the authors independently judged whether subjects' reproductions were altered in the direction suggested by the labels. Carmichael et al. (1932) discovered that the two series of word lists did differentially influence reproductions. In one estimate, 74% of the reproductions were in the direction of the labels that were presented during exposure. On the other hand, 45% of the reproductions of the control group were judged to be similar to labels from either of the series of word lists.

From these findings, Carmichael et al. (1932) concluded that "the experiments here reported tend to substantiate the view that not the visual form alone, but the method of its apprehension by the subject determines...the nature of its reproduction" (p. 83). Thus, their experiment had supported the notion that memories can be altered in the direction of a supplied interpretation or meaning.

Not everyone had been convinced that research results, including those of Carmichael et al. (1932), were conclusive with respect to the existence of alteration in memory. In the views of the critics, distortions of recall did not reflect alterations in memory, but were simply the result of the inabilities of participants with recall tests to reflect what did exist in memory. For example, Hanawalt (1937) demonstrated that distortions in the drawings of forms were common even when the forms were being directly copied.

The critics' arguments were further supported by evidence that participants are able to accurately remember the original forms with recognition memory tests (in which an actual copy of the form was presented at the time of retrieval, see Hanawalt, 1937; Prentice, 1954; Zangwill, 1937). In fact, Prentice discovered that verbal labels did not affect the recognition of forms. Again, using the same figures and word lists developed by Carmichael et al., Prentice introduced a recognition test at retrieval. The recognition test involved 60 figures, each of the 12 originals and 4 distractors for each original. Two of the distractors for each original were modified in the direction of each of the two labels that were paired with each figure. Although there were errors in recognition, the errors were

not systematic with respect to the labels. Prentice concluded that the labels only influence "the activity of drawing" (p. 320), and not the memorial representations themselves.

In reaction to the critics, supporters of the existence of memory change sought to demonstrate alteration with recognition memory tests. Cohen (1966) attributed the failure to date of recognition tests to detect alterations in memory as the result of the distractors in these tests not mirroring the distortions that had existed in memory. In other words, subjects may have altered the figures in memory, but the distractors that were used in the recognition test may have alterations quite different from those that exist in memory. With the exception of some of Zangwill's (1937) retrievals, the distractors were created by the experimenters, not by the subjects themselves. Thus, the recognition tests may be insensitive to detecting the memory changes that do occur.

Cohen's (1966) solution to this problem was to use a simple figure that could vary along only one dimension. The figure that Cohen used was a circle with a 90 degree gap. Subjects were exposed to this figure, and also to four other filler figures, each for 3 seconds. Half of the subjects were told, upon exposure, that the figure resembled "a clock set at 5 min. to 7," and the other half "a clock set at 10 min. to 8" (p. 861). All subjects received a 5 minute retention interval. The sample was further divided into those asked to reproduce the critical figure and the other filler figures, and a condition asked to recognize the critical figure among distractors. The reproduction condition was provided with a compass, graph paper,

and pencils with erasers as aids to drawing. The recognition condition was presented with "a series of 20 circles with gaps...which ranged from 24 [degrees] to 138 [degrees], in equal steps of 6 [degrees]" (p. 861). There were 9 subjects in each of the four conditions.

Cohen (1966) found both reproduction and recognition conditions to be influenced by the labels. Further, the labels were equally effective for both conditions. When presented the "5 to 7" label, the reproduction condition drew a circle with a mean gap of 102.4 degrees, and the recognition condition remembered a circle with a mean gap of 102.5 degrees. When presented the "10 to 8" label, drawings had a mean gap of 65.8 degrees, and recognitions a mean gap of 70.5 degrees. Cohen concluded that the labels did result in altering memory representations.

Additional evidence supporting the existence of memory alteration that used recognition tests was provided by Daniel (1972). Daniel presented to 72 subjects one of four forms for four seconds each. Upon presentation, subjects were told that the stimulus that they were seeing resembled a common animal. In fact, the forms presented were slight distortions of drawings of the animals they were said to resemble. Upon recognition, which occurred either immediately following exposure, or after 5 minute, 20 minute, or 2 day delays, subjects were asked to recognize the form they had seen among 10 other distractors. The distractors were constructed so that five showed gradual alteration in detail toward a form more like the animal named in comparison to the initial stimulus, and the other five were

gradually distorted to be less like the animal named. Daniel found recognitions to be accurate with short delays (immediately and 5 minutes), but that with longer delays (20 minutes and 2 days) subjects selected forms that more closely resembled the label. Daniel concluded that "the observed shifts in recognition memory gradients provide evidence of changes taking place during the storage stage of memory" (p. 156).

Are Daniel's (1972) results conclusive in support of the existence of alterations in memory representations? Of course not. As Loftus and Loftus (1980) point out, a yet to be discovered retrieval test may be able to "disgorge" the original representation from memory. However, Daniel's results are highly supportive of the existence of memory change, and served as an adequate conclusion to the "memory for form" literature with findings that Loftus and associates (Loftus, 1975, 1979a; Loftus et al., 1978; Loftus & Palmer, 1974) sought to extend.

Literature in the Psychology of Testimony

From the inception of interest in the changing content of memories was intertwined interest in the psychology of testimony. In recent times, Loftus and associates have reintroduced this notion which was expressed much earlier during the turn of the century. This early psychology of testimony literature has been conceived as another version of studies looking into memory for form (Woodworth, 1938). Drawings and still pictures were predominantly used as the stimuli to be remembered due to their ease of administration and the ability to

check the reports of subjects against the actual stimuli (Munsterberg, 1908; Stern, 1910; Whipple, 1909). However, also popularized during this time was the interruption of classes with an acted out disruptive event, with some of these disruptions depicting a criminal act. Although the depiction of an event was preferred as stimulus material due to its inclusion of the passing of time as experienced in the world, the use of moving pictures was rare due to the primitive state of technology (however, see Muscio, 1916). In some studies, having subjects observe and remember classroom scientific demonstrations satisfied both of the desired contingencies of using materials that depicted an event and which could also be compared to the reports provided (Whipple, 1912).

Researchers in the psychology of testimony discovered "as the chief single result" that "errorless report is not the rule, but the exception" (Whipple, 1909, p. 161). There was agreement that many of the errors in report were the result of alterations in memory. In a passage reminiscent of Bartlett, Munsterberg (1908) argues that memory alteration serves the purposes of mental economy and adaptation:

We could not fulfil the purposes of our life if we did not disburden our memory constantly of superfluous matter.... We remember well when we select the material, eliminate some parts worthy of being forgotten, and add from our own imagination other parts well adapted to reproduce the original experience. (p. 157-158)

Further, the tendency toward the inaccurate report of detail at the expense of presenting a whole, coherent account of a past experience

is also noted by the psychology of testimony researchers (e.g., Cady, 1924; Stern, 1939). In Stern's (1939) words:

[The] tendency toward logification--the transformation of the unordered and fragmentary chaos of memory images into an ordered, logically satisfactory, and reportable whole--gives rise to many errors in testimony. (p. 6)

Also seen in the psychology of testimony literature is rudimentary research into the influences of postevent information on the memory of a past event. Munsterberg (1908), for example, reports on a study that had presented to subjects "a picture of a farmer's room" (p. 180). During the reporting of what they had seen, subjects were faced with questions that at times were misleading. "The gown of the farmer's wife was red. It was sufficient to ask whether the gown was blue or green to eliminate for many the red entirely from memory" (p. 182). As can be seen, Munsterberg had predated the substitution hypothesis of Elizabeth Loftus and her associates (Loftus, 1979a; Loftus & Loftus, 1980; Loftus et al., 1978), which argues that postevent information can substitute for and erase information encoded from an original event, by about 70 years.

A study by Muscio (1916) is remarkable for its modernity. Muscio had taken several still photographs of events, and devised an apparatus to present the photographs rapidly while producing an effect similar to a moving picture. After exposure to the "films," subjects had to reply to leading and misleading questions. An important finding was that a misleading question containing the pronoun "the" led to more errors in report in comparison to the same misleading

question containing the pronoun "a." Muscio, of course, had only descriptive statistics to depict this finding. Around 60 years later, Loftus and Zanni (1975) found that misleading questions with the pronoun "the" led to significantly more errors in report in comparison to questions containing the pronoun "a," thereby confirming Muscio's earlier findings.

In general, researchers active in the psychology of testimony were aware that reports based on questions, and in particular leading or misleading questions, led to greater inaccuracy of report than did reports provided freely (Cady, 1924; Stern, 1910, 1939; Whipple, 1909). Free reports, however, were noted to be less complete. The difference between the two situations lies in the introduction of postevent information during the asking of questions. The psychology of testimony researchers often interpreted the errors introduced through the asking of questions as reflecting alterations in memory. So did Elizabeth Loftus and her associates, in postevent information studies which will be reviewed at this time.

Recent Postevent Information Studies

Initial Studies and Considerations

In Loftus's first experiment, Loftus and Palmer (1974) showed 45 subjects films of traffic accidents. Immediately following presentation of a film, subjects were interrogated about the accident they had just witnessed. The interrogation was the same for all subjects except for one critical question. One group of subjects was asked, "About how fast were the cars going when they hit each other?"

(p. 586). Other subjects were asked the same question "with the verbs smashed, collided, bumped, and contacted in place of hit" (p. 586). Loftus and Palmer discovered significant differences in speed estimates ranging from 40.8 mph for the smashed group to 34.0 mph and 31.8 mph for the hit and contacted groups, respectively.

Loftus and Palmer (1974) were uncertain whether the significant influence of the verbs on subjects' responses were merely the result of response biases, i.e., "a subject is uncertain whether to say 30 mph or 40 mph, for example, and the verb smashed biases his [or her] response towards the higher estimate" (p. 586), or the result of an actual "change in the subject's memory representation of the accident" (p. 586). A second experiment was performed, that in their view, supported the memory change hypothesis. One hundred and fifty subjects viewed the same film of an accident. At the end of the film, subjects in two experimental groups were asked either the "hit" or "smashed" versions of the same critical question concerning vehicular speed as used in the first experiment. A control group was not asked to estimate vehicular speed. One week later, subjects were all asked without viewing the film again if they had seen any broken glass. Although there was no broken glass in the film, the subjects who were presented the "smashed" verb responded "yes" to the "broken glass" question significantly more often than either the "hit" or the control groups (32% to 14% and 12%, respectively). Furthermore, although the subjects in the "smashed" group responded with estimates of higher velocities, whenever subjects in the "smashed" and "hit" groups responded with equivalent velocity estimates, subjects in the

"smashed" group were still more likely to answer "yes" to the "broken glass" question.

Loftus and Palmer (1974) concluded that their results suggested that the introduction of postevent information (i.e., the verbs, especially "smashed") resulted in an "integrated" single memory of both the event and postevent informations:

We propose that the subject first forms some representation of the accident he [or she] has witnessed. The experimenter then...supplies a piece of external information, namely, that the cars did indeed smash into each other. When these two pieces of information are integrated, the subject has a memory that was more severe than in fact it was. Since broken glass is commensurate with a severe accident, the subject is more likely to think that broken glass was present. (p. 588)

Loftus and Palmer (1974) believed that the effect of postevent information on remembering had "some connection...with earlier work on memory for visually presented form stimuli" (p. 588). The works of Carmichael et al. (1932) and Daniel (1972) were cited as examples of this "earlier work."

The experimenter...is effectively labeling the accident a smash. Extrapolating the conclusions of Daniel to this situation, it is natural to conclude that the label, smash, causes a shift in the memory representation of the accident in the direction of being more similar to a representation suggested by the verbal label. (p. 588)

In essence, Loftus and Palmer proposed that the introduction of postevent information resulted in subjects using their prior knowledge of contexts in which the verb "smashed" is used, and resulted in memory changes similar to those studies in which the remembering of forms have been influenced by prior experience in the use of labels.

A study by Loftus and Zanni (1975), basically a replication of Muscio (1916), again can be seen to involve a role for prior knowledge in the postevent situation. In two experiments, Loftus and Zanni demonstrated that immediately following the viewing of a film, subjects will significantly more likely say that they had seen nonexistent objects if asked in questions containing the article "the" preceding a critical object, for example, "Did you see the broken headlight?" (p. 87), in comparison to questions with the pronoun "a," such as, "Did you see a broken headlight?" (p. 87). The difference regarding the articles "the" and "a" involves our everyday knowledge of the contexts of their appropriate use. "If a speaker has already seen a particular item, and assumes his [or her] listener is also familiar with it, he [or she] will use the article the" (p. 87). In contrast, the use of the article "a" is appropriate when introducing an item.

Loftus and Zanni (1975) believed their results were inconclusive with regard to the occurrence of memory change. The results could merely reflect response bias, in which subjects use different criteria in responding with yes and no depending on which article was presented. However, a "reconstructive memory" explanation was also offered as a possibility. "The definite article ['the'] leads a

subject to infer that the object was in fact present, causing for some a reconstruction in their original memory for the event" (p. 88). Citing the earlier study by Loftus and Palmer (1974), Loftus and Zanni argue that evidence does "indicate that questions asked subsequent to an event can cause a reconstruction in one's memory of that event" (p. 88).

Loftus (1975) extended the findings of Loftus and Zanni (1975), by testing the memory of subjects one week after viewing a film and receiving postevent information. Loftus (1975) demonstrated that postevent information, provided immediately following a film, would lead subjects to significantly more often incorrectly report having seen items that did not appear in comparison to subjects in a control condition (29.2% to 8.4% incorrect, respectively). These items included a school bus, a truck, a center line of a road, a woman (instead of a man), and a barn. The postevent information was introduced in misleading questions with the item preceded by the article "the," for example, "Did you see the children getting on the school bus?" (p. 568). Subjects in the control group did not receive these misleading questions. Upon retrieval, all subjects were directly asked whether they had seen the items in question, which were preceded by the article "a," for example, "Did you see a school bus in the film?" (p. 568). Loftus interpreted the significant findings as suggesting that the postevent information for many subjects was "integrated" into a representation of the event that was initially formed during acquisition, resulting in an alteration of the initial representation. Upon retrieval, an image of the event becomes

regenerated "based upon the altered memory representation" (p. 571). Apparently, subjects who were misled about items in the film continued to infer their existence one week later.

Consider also the related research of Spiro (1977, 1980) with verbal materials. Spiro argued that his research with postevent information demonstrated that remembering at times involves an "inferential reconstruction" of the past. Heavily influenced by Bartlett (1932), Spiro argued that "cognitive structures" or "schemata," the "cumulative, holistic, assimilative blends of information" (1977, p. 137) that exist in memory, were extremely important for their role during remembering. In Spiro's scheme, "reconstructive errors," or inaccuracies during retrieval, are dependent upon "the degree of interaction with pre-existing cognitive structures" (1977, p. 139) that become accessed following the introduction of postevent information.

Spiro (1977, 1980) cites evidence gathered from his dissertation as support for his model. In this research, subjects read one version of a story concerning an engaged couple--Bob and Margie. Before reading the stories, subjects were informed that the experiment dealt with their understanding and reactions to interpersonal situations. In one story, Bob desires not to have children and is reluctant to inform Margie of this fact. Finally, Bob tells Margie and discovers that Margie is "horrified...since having children is very important to her" (1977, p. 142), and an argument ensues. After an eight minute delay, the experimenter either introduced postevent information that Bob and Margie are currently happily married (experimental group), or

no further information was provided (control group). Subjects were dismissed and returned either two days, three weeks, or six weeks later, in order to recall the original story.

Spiro (1977, 1980) reports that in his dissertation he had predicted a priori the types of reconstructive errors that subjects who were provided postevent information should make during recall. For example, subjects might recall that Margie finally agreed with Bob not to have children, that the argument over having children was not very important, or that the couple had originally agreed to have children. Such reconstructive errors were predicted to not occur with the control condition. Only those errors predicted a priori were counted for data analyses; omissions and other alterations were not counted as errors.

Spiro (1977, 1980) found, as predicted, that significantly more errors were committed by subjects in the experimental group in comparison to subjects in the control group. Further, the number of reconstructive errors increased with the amount of delay with the experimental group. According to Spiro, during recall, any remaining details of the story and the postevent information would integrate with "schemata concerning knowledge of how interpersonal relations usually work" (1977, p. 143). That is, being informed that Bob and Margie did happily marry, in terms of the ordinary understanding of interpersonal relations, is in conflict with the information in the story that a bitter argument had ensued during the engagement concerning having children. During the inferential reconstruction at recall, there occurred a "reconciliation of the conflicting elements"

(1977, p. 143). Subjects inferred that the story of the engagement was not all that (or at all) bitter. Any original representation of the event had "accommodated" toward the direction of the postevent information (Spiro, 1980).

The fact that reconstructive errors increased with delay suggested to Spiro (1977, 1980) that the reconstruction occurred at the time of retrieval, not at the time when the postevent information was introduced. In light of other work that has shown that intrusions of inferences will increase with increased delay (e.g., Brewer & Dupree, 1983; Crosland, 1921; Daniel, 1972; Graesser, Woll, Kowalski, & Smith, 1980), a more precise explanation of Spiro's findings can be offered. As details of the event become less accessible over time, inferences based on prior knowledge become more pronounced. The postevent information of a happy marriage may be retrieved and used to infer details concerning happy marriages that will intrude in the attempts at remembering the original story. In addition, the results of Loftus and Palmer (1974) also appear as the result of the use of inferences based on prior knowledge during retrieval, with the postevent information of their being a "smash" leading subjects to use their knowledge of what a severe accident would be like.

The findings reported by Loftus and Zanni (1975) and Loftus (1975) are not quite explainable by an appeal to the activation of details inferred from prior knowledge upon retrieval. In these studies, the introduction of postevent information had directly misled subjects as to certain detail having occurred. That is, detail was not inferred from one's prior knowledge, the detail was directly said

to have been present in the event by the experimenter. However, inference did play some role in the latter studies: the article "the" led subjects to infer the appearance of items that were not actually present in the event.

Consider, however, a situation in which a certain item appears in an event, and with the introduction of postevent information, a different item is said to have been present instead. This scenario is different from one in which nonexistent items can be inferred to have existed. Will subjects be able to infer the existence of one item (the postevent item) in place of another item (the event item)? It would seem that the ability to make such an inference becomes more strained.

Yet, Loftus et al. (1978) did provide evidence that such an alteration can take place. One hundred and ninety five subjects were shown one of two versions of 30 color slides that depicted a sequence involving a car hitting a pedestrian. Only one slide was different with the two versions of slides, and this slide was the same except that either a stop sign or a yield sign was shown. Immediately after viewing the slides, subjects were asked to respond to questions. Embedded in these questions was reference to either a stop or yield sign. Thus, approximately half of the subjects received consistent postevent information (i.e., asked a question with reference to the type of sign that was shown originally), and the other half received misleading postevent information. After the questions containing postevent information were answered, subjects participated in a 20 minute filler activity, followed by a recognition test. Fifteen pairs

of slides were presented during retrieval, with one slide from each pair being a slide exactly the same as a slide originally presented. One pair consisted of both the stop and yield sign slides.

As expected, subjects who had received misleading postevent information correctly selected the "old" stop or yield sign slide significantly less often than subjects in the consistent condition (41% to 75% correct, respectively). Further, subjects in the misled condition performed significantly poorer than chance (i.e., 50% correct) expectation.

Loftus et al. (1978) believed that their findings supported the notion that for some subjects the misleading postevent information had in some way altered the memory for the original event information. Before asserting this notion as their conclusion, however, Loftus et al. addressed two other interpretations. One interpretation was that misled subjects knew which slide they had seen initially, but responded with the misled alternative because they remember the experimenter had informed them as such after the event, and they either reasoned the hypothesis of the experimenter and yielded to demand characteristics, or reasoned that they must be wrong about what they saw and that the experimenter must be right. As evidence against this explanation, Loftus et al. repeated the experiment with a different sample of 90 subjects, with the exception that a follow-up questionnaire was provided to subjects after recognition. In the follow-up questionnaire, subjects were directly asked whether they had initially seen a stop or a yield sign, and whether in the questions asked immediately after the slides whether there had been reference to

a stop, yield, or no sign. Loftus et al. discovered that of the misled subjects who provided an incorrect response upon recognition, only 12% were correct on the follow-up questionnaire. They concluded that the demand characteristics explanation was an inadequate interpretation of the data.

The other possible interpretation of their findings was that for many misled subjects, the original information from the slides was not encoded, with subjects responding on the basis of misleading postevent information alone. To counter this interpretation, 90 subjects were shown one of both versions of the series of slides, and were then immediately asked to draw on an empty diagram of an intersection, what they had seen. Approximately half the subjects drew or wrote the name of the sign they had seen. Loftus et al. argued that the sign which was shown was sufficiently encoded by most subjects given that at least half can recall the sign with minimal prompting.

Loftus et al. (1978) concluded that the misleading postevent information did "integrate" into memory, resulting for many to "reconstruct a 'memory' that was never actually experienced" (p. 31). They considered their findings to resemble influences shown by Carmichael et al. (1932) and Daniel (1972) with respect to verbal labels and memory for form. They did not address the distinguishing characteristics of their study, namely, whereas the memory for form research led subjects to infer default detail based on prior knowledge, in the Loftus et al. study, the altering detail was provided by the experimenter. This distinction is extremely important toward understanding some findings of Loftus et al. that will be

reported at this time.

Recall that in Daniel's (1972) study, as well as in Spiro's (1977, 1980) postevent information study, that as details of the original event became forgotten over time, inferences based on prior knowledge became more and more representative of subjects' retrievals. That is, retrievals became less accurate with increasing delay. Loftus et al. (1978), on the other hand, found that misled subjects became significantly more accurate with increasing delay. That is, subjects who were misled immediately after viewing the slides performed below chance level with recognition tests offered 20 minutes to 2 days later, but at chance level after a delay of one week. Apparently in the Loftus et al. study, details presented both during and after the event were becoming forgotten with delay.

The fact that there is a different pattern of results dependent on whether the inaccurate details are supplied by the subjects' own prior knowledge, or by the experimenter, may signal the existence of different processes leading to altered retrievals. When the details are inferences made by the subjects, the alteration typically appears to undergo a rather gradual transition (see Crosland, 1921; Daniel, 1972; Loftus & Palmer, 1974; Spiro, 1977, 1980). When the detail is introduced by the experimenter, the alteration appears quite sudden and immediate (e.g., Loftus et al., 1978). For example, Daniel (1972) found no distortions in the direction of the labels with retrievals that occurred immediately following acquisition, only with delay did the alterations appear. On the other hand, Loftus et al. (1978) found the greatest influence of misleading postevent information with

retrieval tests that occurred immediately after the introduction of the postevent information, with a gradual decrease in influence with increasing delay.

Despite the possible distinction between influences resulting from inferences made from prior knowledge versus detail introduced by the experimenter, and the fact that some postevent information studies are of the former type (e.g., Loftus & Palmer, 1974; Spiro, 1977, 1980), whereas other postevent information studies are of the latter type (e.g., Loftus et al., 1978), hypotheses regarding the influence of postevent information on memory have been offered primarily to account for findings that occurred when detail was introduced by the experimenter. In addition, these hypotheses have been tested by studies in which (again) the experimenter introduces detailed postevent information. This concern with this one type of postevent information study, to the exclusion of introducing postevent information that leads to the use of inferences based on prior knowledge, is perhaps due to the Loftus et al. study having been extremely provocative and convincing that postevent information can alter the memory for original event information. That is, the Loftus et al. study served as an exemplar for the later studies.

The Substitution and Coexistence Hypotheses

Loftus et al. (1978) recognized that two hypotheses regarding the nature by which misleading postevent information influences the memory for the original event information were possible. The more radical hypothesis views the process as one of substitution, "that the

misleading information has irrevocably replaced the original information" (Loftus & Loftus, 1980, p. 418). This radical hypothesis will be referred to as the substitution hypothesis. The second hypothesis asserts that the misleading postevent information does not erase original event information, but lends the original information to be difficult or impossible to retrieve. This second hypothesis will be termed as the coexistence hypothesis.

In follow-up research, Loftus and associates (i.e., see Loftus, 1979a, 1979b; Loftus & Loftus, 1980) attempted to "disgorge" the original event information, reportedly without success. They attempted monetary rewards for correct retrievals, investigated whether second guesses systematically revealed the remembering of the event information, and provided subtle warnings at the time of retrieval that there had been misleading information. The failures of subjects in these attempts to demonstrate the existence of the original information was interpreted as support for the substitution hypothesis.

Later researchers, however, would provide evidence in support of the coexistence hypothesis. There were two methods which were somewhat successful in demonstrating the existence of the original information in memory: 1) warning subjects of having been misled, and 2) reproducing at the time of retrieval the sequence of events that had occurred during acquisition. Although this research has not been entirely convincing in support of the coexistence hypothesis (see below), the net effect was to seriously dispute the substitution hypothesis. In addition, later research would prove even more

damaging to the substitution hypothesis, and would even challenge whether postevent information had any influence at all upon an original representation of an event.

Warning studies. The first studies that explored whether warnings of being misled would reduce or eliminate the influence of postevent information used warnings that were implicit in nature. For example, Loftus (1979b) found that misleading postevent information (contained in a narrative) that was blatantly false would not influence later retrievals. More importantly, Loftus also discovered that when the blatant misleading information was introduced at the same time that other misinformation was introduced, the influence of the other misleading information was likewise reduced in comparison to a condition in which no blatant information was presented. Apparently, the blatant misinformation warned subjects that there was inaccurate information in the narrative, and not to heed the information that the narrative contained. Similar findings were reported by Dodd and Bradshaw (1980), who discovered that misleading postevent information that was attributed to an unreliable source (e.g., the driver of a car involved in a presented accident) would not influence the accuracy of later retrievals.

These studies, of course, simply suggest that when postevent information is suspected of being unreliable at the time of presentation, it will not be accepted into memory in the first place. Thus, these studies have no bearing on either the substitution or coexistence hypotheses. On the other hand, if providing a warning at the time of retrieval leads to an improvement in accuracy over

non-warned subjects, then evidence for coexistence would be at hand. In an initial study, Loftus (1979b) found that introducing blatant misinformation shortly before retrieval, and one hour following the introduction of other misleading postevent information, did not improve retrieval accuracy. Greene, Flynn, and Loftus (1982) attempted a more explicit warning, informing subjects that "some" of the postevent information "may have been inaccurate" (p. 210). Again, retrieval accuracy did not show any improvement.

By using an even more explicit warning, Christiaansen and Ochalek (1983) argued that they had discovered "evidence for the coexistence of original and postevent information" (p. 469). As per their expectation, misled warned subjects were as accurate as control subjects, who were significantly more accurate than misled nonwarned subjects. According to Christiaansen and Ochalek, the introduction of postevent information does make the original event information more difficult to retrieve, however, event information is not irrevocably lost. By providing an explicit warning at the time of test, subjects were induced to successfully search for the original information of the event in memory, which coexisted with the postevent information.

Before accepting the conclusion of Christiaansen and Ochalek (1983), a relatively detailed and critical review of their study is in order. Like all postevent information studies, there were three main phases to Christiaansen and Ochalek's research: 1) the presentation of an initial event (a series of slides), 2) the introduction of postevent information (a narrative), and 3) the retrieval test (a multiple-choice verbal recognition test). In addition, following the

initial event presentation, subjects were given an accuracy questionnaire. The accuracy questionnaire consisted of a series of multiple-choice questions concerning items that were presented in the slides. Four of the questions dealt with critical items, that is, items to which misled subjects would later receive postevent misinformation. These same four questions, with the same choices of answers (including event information, postevent information, and two other possibilities as alternatives), also appeared on the retrieval test.

Christiaansen and Ochalek (1983) introduced the accuracy questionnaire in order to weed out those subjects who did not remember the original event information. They reasoned that "since one can only expect to retrieve from episodic memory that which has been encoded, tests for the retrieval of original memories should be done only on material for which a subject has demonstrated some initial memory" (p. 473). Christiaansen and Ochalek were aware that providing subjects the opportunity to rehearse what they saw may make the misleading postevent information less effective, thus they introduced a lengthy retention interval of 48 hours between acquisition and the introduction of the postevent narrative. The retrieval test occurred within 45 minutes of the postevent narrative.

Although Christiaansen and Ochalek (1983) are correct that it is most desirable to determine whether misleading postevent information has any influence on information that is known to have been previously encoded, the introduction of the accuracy questionnaire resulted in their findings to be uninformative. Most problematic is the inability

to determine whether subjects are remembering the original event, or their answers on the accuracy questionnaire. If subjects are responding with respect to their remembrances of their responses to the questionnaire, then neither support for nor against either the coexistence or substitution hypotheses is possible.

My critique will assume that whereas subjects remember their responses to the accuracy questionnaire, they effectively do not remember what had been shown in the slides, despite the fact that the retrieval test occurred approximately two days after each of these two phases of the experiment. Wouldn't their memory of both of these phases equally deteriorate over the retention interval? Perhaps so, but what must be acknowledged is that the critical questions in the retrieval test were exactly the same as on the accuracy questionnaire. There is a body of evidence that has demonstrated that when the conditions at the time of retrieval mirror the conditions at the time of acquisition or encoding, the recovery of the encoded information will be enhanced (e.g., see Tulving & Thomson, 1973). When asked the same question two days later, subjects are quite likely to remember their initial response.

Certainly we know that subjects responded correctly on the accuracy questionnaire (as data from incorrect responses were excluded from analyses), but at least some of these correct responses were guesses. Also, although other subjects may have responded correctly on the accuracy questionnaire because they remembered at that time of seeing the items in question, by the time of the retrieval test, even though they may have remembered their initial responses, they may have

forgotten whether these responses were correct. According to this scenario, Christiaansen and Ochalek's (1983) findings can be interpreted quite differently. The subjects provided misleading postevent information will reason that their responses were wrong and opt for the misled alternatives. The subjects warned about the postevent misinformation will reason that their initial responses were right and reject the misled alternatives as inaccurate. In sum, the conclusion that the warning led subjects to access information contained in an original episodic representation of the observed event is unwarranted (see McCloskey & Zaragoza, 1985a, for different objections to the conclusions of Christiaansen and Ochalek).

The importance of retrieval conditions. My reinterpretation of the findings of Christiaansen and Ochalek (1983) receive further support in light of other recent postevent research demonstrating the importance of the similarity between acquisition and retrieval conditions. Bekerian and Bowers (1983) discovered that when retrieval conditions are provided that are similar to the conditions that occurred during the observation of an event, an improvement in the accuracy of subjects' recognitions in the face of misleading postevent information will result. Bekerian and Bowers correctly concluded that their findings supported the coexistence hypothesis. As will be seen, however, their own follow-up work (Bowers and Bekerian, 1984) resulted in their research to be ultimately inconclusive with respect to the substitution/coexistence issue.

In correspondence with Elizabeth Loftus, Bekerian and Bowers (1983) learned that the recognition test of Loftus et al. (1978) presented the pairs of stop/yield sign slides in a random order. Using the same experimental materials and method as Loftus et al., Bekerian and Bowers included the random order recognition test, but also introduced a condition in which the recognition pairs of slides were presented in the same sequential order as had been shown during the viewing of the initial event. They replicated Loftus et al.'s findings that subjects who received misleading postevent information would significantly more often choose the misled alternative on a randomly ordered recognition test in comparison to subjects who received consistent postevent information. On the other hand, with the sequential recognition test, the performance of misled subjects did not differ from subjects who received consistent information.

In followup research, Bowers and Bekerian (1984) discovered another salient variable, the order of the questions containing the postevent information. In both Loftus et al. (1978) and Bekerian and Bowers (1983), the questions were presented in a random temporal order (i.e., an order not consistent with the sequencing of the slides). Bowers and Bekerian, in addition to keeping the same conditions as Bekerian and Bowers, also introduced conditions in which the postevent information was presented in questions preserving the same temporal sequencing as the slides. With subjects exposed to the random questionnaire, the findings of Bekerian and Bowers were replicated: misled subjects given a random recognition test preferred the misled alternative; misled subjects rejected the misled alternative with a

sequential test. However, when the postevent information was introduced in a sequential questionnaire, misled subjects consistently selected the misled alternative with both random and sequential recognition tests.

Bowers and Bekerian (1984) conclude that taken together, both studies support the coexistence hypothesis. "Because the present study replicates Bekerian and Bowers (1983) we can conclude--as before--that the effects of PEI [i.e., postevent information] in this experiment cannot be due to the...substitution of information in memory" (p. 470). However, another interpretation of their findings is possible. When misleading postevent information is introduced non-sequentially, the postevent information will coexist with original event information. When misleading postevent information is introduced sequentially, the postevent information will substitute for or replace the original event information.

In any event, the studies by Bekerian and Bowers (1983; Bowers & Bekerian, 1984) demonstrate that not only are retrieval conditions important toward possibly increasing access to the original event information from memory, but that different conditions in which postevent information is presented may involve differences in the processing and storage of this information. In even more recent research, McCloskey and Zaragoza (1985a) have shown that even when postevent information is introduced in a manner that preserves the sequence of the event, misled subjects can retrieve the original event information to an equivalent extent as control subjects. Clearly, this latest research supports the coexistence hypothesis. However,

McCloskey and Zaragoza argue that their evidence disputes not only the substitution hypothesis, but the coexistence hypothesis as well. In their view, misleading postevent information has no effect on the ability of subjects to remember the original event.

The No Effect Hypothesis

The evidence by which McCloskey and Zaragoza (1985a) have challenged memory change hypotheses with respect to the introduction of misleading postevent information again relies on the importance of retrieval conditions. McCloskey and Zaragoza argue that the forced-choice recognition task of Loftus et al. (1978) simply provided the appearance that misleading postevent information influenced the memory of original event information. In McCloskey and Zaragoza's analysis, at the time of test in both control (i.e., subjects who would receive neutral postevent information) and misled conditions, the same proportion of subjects would "remember" and "not remember" the original event information. With control subjects, faced with the selection between the slide they had originally seen and (for them) a novel slide, those who remember will choose correctly and those who do not remember will make a 50/50 guess. With misled subjects, choosing between the original slide and the misled alternative, those who remember will again choose correctly. With misled subjects who do not remember the event information, the situation becomes a bit more complicated. Because a proportion will remember the postevent information, there will be a tendency to select the misled alternative above that of chance (i.e., 50%) selection. Thus, according to this scenario, inaccurate responses by misled subjects in excess of those

provided by the control subjects result as an artifact of the retrieval task.

To correct for the problems raised by the retrieval task of Loftus et al. (1978), McCloskey and Zaragoza (1985a) introduced what they termed as a "modified test procedure." Instead of using a forced-choice retrieval test between the initial event item and the misled item, McCloskey and Zaragoza introduced a forced-choice test between the event item and a novel item (an item that was not used as misleading postevent information). McCloskey and Zaragoza reasoned that for subjects who do not remember the event information, the modified test procedure would result in misled subjects to make the same 50/50 guess as control subjects. On the other hand, for subjects who do remember the initial event information (or otherwise, without postevent information, would remember the event information), the modified test procedure would demonstrate whether or not postevent misinformation alters an original representation of the initial event item.

McCloskey and Zaragoza (1985a) employed both the retrieval test of Loftus et al. (1978) and their modified test procedure in six similar experiments involving a total of 720 subjects. All studies had subjects exposed to both misleading postevent information on some critical items, and neutral postevent information on other items. (You may remember that previous studies had used consistent postevent information for their control conditions, that is, if shown a stop sign, subjects were later informed that they had seen a stop sign. With neutral postevent information, subjects would be later informed

that they had seen a traffic sign.) In all experiments, McCloskey and Zaragoza found a significant difference in the recognition performance of control and misled conditions using the Loftus et al. procedure, but no significant differences occurred with the modified test procedure. McCloskey and Zaragoza concluded that the nonsignificant findings demonstrated that "misleading postevent information does not impair subjects' ability to remember what they originally saw.... Misleading information neither erases the original information nor renders it inaccessible" (p. 7). The arguments and evidence of McCloskey and Zaragoza have raised a serious challenge to both the substitution and coexistence hypotheses.

Their challenge is best addressed by noting some of the difficulties with the no effect hypothesis. The crux of McCloskey and Zaragoza's (1985a) arguments rests with their assumptions that subjects either "remember" or "do not remember" what they saw. Further, given that misleading postevent information has no influence on the likelihood of remembering what was seen, misled subjects, during retrieval, must have an intact representation of the original event, and an ability to discriminate the misleading postevent information as not belonging to the original event. This claim by McCloskey and Zaragoza disputes two possibilities in which the introduction of misleading postevent information can influence the memory for original event information. The first possibility proposes that in some situations event and postevent informations may integrate resulting in compromise memories. Compromise memories are hypothesized to occur when event and postevent informations provide

different estimations along some continuous dimension (see Loftus, Schooler, & Wagenaar, 1985). For example, there has been evidence of compromise memories in remembering number (Loftus, 1975) and color (Belli, 1987; Loftus, 1977). The second possibility is the coexistence hypothesis, and involves properties that lie on a discrete dimension, as we have seen with items such as stop and yield signs. According to the coexistence hypothesis, although the original event information is not lost from memory, the postevent information causes the event information to be more difficult to retrieve. Both of these possibilities will be considered as potential problems for McCloskey and Zaragoza's (1985) no effect hypothesis.

Compromise memories. Loftus (1975) presented to 40 subjects a videotape that depicted a classroom being disrupted by eight demonstrators. Immediately following the videotape, subjects were asked a question that suggested that there were either four or twelve demonstrators. One week later, all subjects were asked to estimate the number of demonstrators that they had seen in the film. Subjects provided postevent information of there having been four demonstrators had a mean recall of 6.4 people; subjects in the "twelve" condition recalled on the average 8.9 people. Only 10% of subjects simply responded with the same number as had been suggested to them by the postevent information. Responses reflected a compromise between event and postevent informations.

In another study suggesting a compromise memory, Loftus (1977) presented to 100 subjects a slide presentation that included a green car. Immediately following the presentation, half of the subjects were misinformed that the car was blue, and the other half (control condition) received no postevent information concerning the color of the car. After a 20 minute filler activity, subjects were asked to recognize the color of the car by selecting from a number of hues representing the visual spectrum. In comparison to the control condition, misled subjects significantly more often selected bluish hues. In addition, the most frequent recognitions among misled subjects were hues that were blue-green blends, a compromise between event and postevent informations. Loftus (1977) concludes by suggesting the occurrence of a "blend" of "information" that "becomes integrated to form a single memorial experience" (p. 699).

McCloskey and Zaragoza (1985a, 1985b) argue that such evidence for compromise memories does not challenge their no effect hypothesis. Such compromises, they argue, may be the result of subjects who remember both the event and postevent informations, but who make a deliberate compromise with their responses. For example, a subject may remember seeing a green car, and also remember being informed that the car was blue. When asked to select a color, the subject may reason that the color of the car could be described as being both green and blue, and make a compromise response. According to McCloskey and Zaragoza, a compromise response is not necessarily a reflection of a compromise memory.

This paper has already reported a similar argument against memory change hypotheses that were offered by Hanawalt (1937) and Prentice (1954). Both Hanawalt and Prentice disputed the interpretations and Carmichael et al. (1932) and others with regard to distortions in drawn reproductions being reflections of altered memories. For Hanawalt and Prentice, inaccuracies were the result of the act of drawing itself, and did not reflect changes in the memorial representations of the original forms.

In essence, Hanawalt and Prentice were disputing the hypothesis that memories can change as a compromise of event information integrating or assimilating with prior knowledge (e.g., Bartlett, 1932; Carmichael et al., 1932; Crosland, 1921; Gibson, 1929; Philippe, 1898). Compromise memories resulting from an interaction between what was seen and prior knowledge has been suggested by more recent evidence as well (e.g., Cohen, 1966; Daniel, 1972). Although McCloskey and Zaragoza (1985a, 1985b) direct their comments to compromises that occur following the introduction of postevent information, their position may more effectively be evaluated by considering compromises that result from the influence of prior knowledge.

In my own work (Belli, 1987), I have additional evidence suggesting that compromise memories will result from an integration of event information and prior knowledge. In my study, 102 subjects were asked to select from a number of hues representing the visual spectrum the most probable colors of several items, including a plastic pitcher. Most people selected yellowish hues as a plastic pitcher's

most probable color. One week later, I presented to these subjects a series of slides that included a green plastic pitcher. After a 20 minute filler activity, subjects were asked to select a hue that matched the color of the pitcher they had seen. Subjects often selected hues that were yellow-green blends. In addition, subjects who chose yellow hues as the most probable color significantly more often recognized the green pitcher as more yellowish in comparison to subjects who selected hues other than yellow as a plastic pitcher's most probable color.

My work (Belli, 1987) also tested whether the green plastic pitcher was misperceived as being yellowish. To test this possibility, 88 subjects were shown the slide of the green plastic pitcher, and immediately following this presentation, asked to select the matching hue. Subjects accurately selected green hues.

That the subjects in my study (Belli, 1987) only compromised event color information with their prior knowledge of probable coloring when a considerable delay had occurred after acquisition, with no compromise resulting with recognitions immediately following acquisition, is a finding consistent with other research (e.g., Crosland, 1921; Daniel, 1972; Graesser et al., 1980) that demonstrates the influence of prior knowledge upon retrieval with increasing delay. In my interpretation of my results, most people have prior knowledge that plastic pitchers are yellow. The event green information fades or loses distinctiveness over time. Upon recognition, subjects use their prior knowledge to help reclarify a color for the pitcher, resulting in an alteration in the representation of the pitcher to

include both yellow and green.

The evidence that compromise memories occur with the influence of prior knowledge raises doubts with respect to McCloskey and Zaragoza's (1985a, 1985b) contention that the postevent situation involves only deliberate compromises. This notion becomes clearer when an attempt is made to use the deliberate compromise explanation to account, for example, for my findings (Belli, 1987). For a deliberate compromise to occur between the event green information and the prior knowledge of pitchers generally being yellow, intact representations of both types of information must be accessed during retrieval. Consider the prior knowledge first. According to Minsky (1975), prior knowledge may arise to awareness, and an individual, for example, may conjure up an image of his or her yellow plastic pitcher at home. However, given that an individual accesses an intact representation of the green pitcher in the slides, why would such an individual 1) conjure up a representation based on prior knowledge in the first place, and 2) deliberately choose a compromise of both sources of information? Any compromising, it appears to me, would result precisely because an intact green representation of the pitcher was not accessible at the time of retrieval.

In the postevent situation as well, it appears doubtful that subjects are able to access an intact representation of event information. Given that an intact representation of event information is not accessible, any deliberate compromise appears unlikely. What is more suggestive is the possibility that (at the very least) the postevent information is used at the time of retrieval to reclarify

the content of the memory. Such a retrieval process may involve the alteration in the content of the representation of the event that results in a compromise memory of both event and postevent informations.

In the past, objections to the occurrence of compromise memories was supported by evidence that subjects will be accurate during recognition tests (e.g., Hanawalt, 1937; Prentice, 1954). Cohen (1966) and Daniel (1972), however, have demonstrated compromises along continuous dimensions with recognition tasks, supporting the existence of compromise memories. If McCloskey and Zaragoza (1985a, 1985b) are correct that despite the tendency toward making compromise responses, an intact representation of event information resides in memory, then a retrieval test should be devisable that would lead to accessing the intact information among misled subjects. In the absence of this evidence, the notion of compromise memories remains as a viable hypothesis to account for compromise retrievals.

Memories of items and coexistence. The literature concerning compromise memories suggests that the introduction of misleading postevent information results in an alteration in the content of a representation of event information. Even so, the influence of the postevent information does not involve the complete loss of the event information, since the event information is only compromised by the postevent information. However, when dealing with the remembering of discrete information, such as items, any influence of the postevent information cannot result in compromise memories (however, see Loftus et al., 1985, for suggestions that compromise memories can involve

items, and also see McCloskey & Zaragoza, 1985b, for critical commentary concerning this notion). But there are potentially other influences, which become revealed by a more detailed exposition of the coexistence hypothesis.

The coexistence hypothesis has at times been seen as a derivation of the classic interference theory of forgetting (Bekerman & Bowers, 1983; Loftus & Loftus, 1980). Interference theory developed out of work that has typically involved the learning of two different word lists to criterion, a first list (learned to a criterion first) and an interpolated list, and then measuring the amount of material that could be recalled from the first or both lists (see Crowder, 1976; Klatzky, 1980). Retroactive inhibition occurs when learning the interpolated list results in recall performance for the first list to be poorer in comparison to a control condition. Although there has been some reservation over the fact that the research paradigms of traditional interference work and the postevent information studies differ (see Loftus & Loftus, 1980, Zaragoza, McCloskey, & Jamis, 1987), and that there may be different processes of forgetting associated with recall tests of word lists learned to a criterion (typical interference studies) versus recognition tests of stimuli presented during single exposures (typical postevent information studies), it may yet be appropriate to consider results demonstrating an influence for misleading postevent information as a special case of retroactive inhibition.

Interference theorists have proposed two factors to account for retroactive inhibition (Crowder, 1976; Klatzky, 1980). McGeoch (1942) hypothesized that forgetting was the result of response competition, namely, that elements of the interpolated list competed with elements from the first list with the responses on the recall tests. According to McGeoch, elements of the first list remained in memory, and were available at the time of test, however, competition from the interpolated list resulted in elements from the first list to be more difficult to access and retrieve. In fact, it appears that the response competition hypothesis is what several recent authors have had in mind when discussing the coexistence hypothesis.

The second factor in interference theory that has been hypothesized to account for retroactive inhibition has been termed as unlearning (Barnes & Underwood, 1959; Melton & Irwin, 1940). With unlearning, the introduction of the second list results in an actual loss in the availability of elements from the first list. Complete unlearning would be equivalent to substitution (given that elements of the interpolated list were still retained). However, unlearning can also exist as a partial influence, with the interpolated list simply reducing the distinctiveness (or response strength) of the first list. In the postevent situation, unlearning would involve a loss of distinctiveness for the event information, although the event information could still coexist with the postevent information.

Besides response competition and unlearning as potential influences of misleading postevent information, a third potential influence, derived outside of interference theory, has been recently offered by Johnson and Lindsay (1986). In their view, both event and postevent informations may be accessed at the time of retrieval. However, due to the introduction of the misleading postevent information, subjects may be confused whether the event item or the postevent item was actually observed. That is, subjects may forget the respective sources of information, with misled subjects becoming susceptible to source attribution error.

Thus, all three of the above mentioned possibilities, response competition, unlearning, and source attribution error, are able to assume the coexistence of event with postevent informations, yet nonetheless will involve a memory impairment (or alteration) of event information due to the introduction of misleading postevent information. The important point is that the modified test procedure of McCloskey and Zaragoza (1985a) is not sensitive to any of these potential influences. In the modified test, subjects are faced with a forced-choice decision between the event item and a novel item. Unless the postevent information has substituted for the event information, the event item will be the preferred response on the modified test. If response competition between the event item and misled item exists, any difficulty in accessing the event item due to competition from the misled item will be overcome because the misled item does not compete as an alternative on the test. Unless accessing the event item is an impossibility, the event item will be accessed

and selected over the novel item. If any unlearning for the event item has occurred, unless the unlearning is complete, there would be some memory for the event item that would entail its selection on the test. If misled subjects do not remember the source of the event item, subjects will still prefer the event item due to it simply being more familiar than the novel item.

The no effect hypothesis of McCloskey and Zaragoza (1985a, 1985b) also becomes questionable in consideration of the findings of Bekerian and Bowers (1983) and Bowers and Bekerian (1984; below, both studies will be often cited as Bekerian and Bowers). In McCloskey and Zaragoza's analysis, the recognition test of Loftus et al. (1978), in which subjects are forced to choose between the event item and the misled alternative, will always result in misled subjects to perform more poorly than control subjects. In their view, a proportion of misled subjects who do not remember the event information will remember the postevent information, and select the misled alternative on the basis of believing the postevent information as accurate. In contradiction to McCloskey and Zaragoza's prediction, Bekerian and Bowers (both studies) found that misled subjects in a certain condition will respond as accurately as control subjects, with an event item vs. postevent item forced-choice retrieval test. This condition involves introducing postevent information in a random set of questions, and providing subjects a retrieval test in which pairs of slides are presented in the same sequential order as slides shown originally. All other conditions attempted by Bekerian and Bowers resulted in poorer performance by misled subjects. These findings

suggest that postevent information does impair the ability to remember event information, and with only a special set of circumstances will the event information be accessed and retrieved.

McCloskey and Zaragoza (1985a) have recognized that the findings of Bekerian and Bowers (1983) threaten their no effect hypothesis. They have simply deemed the findings as "anomalous." (McCloskey and Zaragoza attempted to replicate Bekerian and Bowers, 1983, apparently without having seen the study by Bowers and Bekerian, 1984, thus not knowing the importance of the order in which postevent information is introduced. Their determination of the findings as anomalous resulted from their failure to replicate the results of Bekerian and Bowers, 1983, while introducing postevent information in a sequential narrative.) Although the findings are anomalous to McCloskey and Zaragoza, the results of Bekerian and Bowers (both studies) do make sense if one assumes that the introduction of misleading postevent information influences the memory of what was actually experienced. With the introduction of postevent information in a random order, a sequential retrieval test disambiguates what was seen originally as the similarity of the order of presentations at acquisition and retrieval provides the necessary information to distinguish what was initially seen and what was presented after the event in a disordered (i.e., random) fashion. When the misleading postevent information is itself introduced sequentially, however, there is no longer any dissimilarity with the order of presentation between the original event and the postevent information, and a sequential retrieval test offers no disambiguating information.

Assuming that the introduction of postevent information does influence the memory of what was originally seen, the modified test procedure of McCloskey and Zaragoza (1985a) must be considered insensitive toward measuring the influence of postevent information. However, consider misled subjects who are faced by only the event item during retrieval, and are asked to respond yes or no as to whether they had seen the item. Not being able to compare the event item against a novel item as in the modified test procedure, the subjects would be susceptible to demonstrating the memory impairing influences of the misleading postevent information. If there is response competition between the event item and the misled item, misled subjects may have a tendency to say 'no' to the event item due to their initially accessing an internally generated misled alternative. If there is unlearning, misled subjects might frequently say 'no' to the event item sensing an indistinct memory as unreliable. If there is source attribution error, misled subjects may have a tendency to say 'no' because of the uncertainty as to which item was actually experienced. In comparison to control subjects, misled subjects would perform more poorly.

On the other hand, if McCloskey and Zaragoza (1985a, 1985b) are correct that postevent information has no influence on the remembering of event information, then misled subjects, when faced by the event item alone during retrieval, ought to correctly respond (given that they remember the event information). They would be subject to no disadvantage in comparison to a control condition.

Rationale for the Current Experimental Investigation

The proposed experiment is designed as a test between the no effect hypothesis of McCloskey and Zaragoza (1985a, 1985b) and the coexistence hypothesis which asserts that misleading postevent information results in some impairment in the ability to remember the original event item. My proposed retrieval test is based on the acceptance of McCloskey and Zaragoza's assumptions regarding subjects as either remembering or not remembering the event information. I will demonstrate that if McCloskey and Zaragoza's no effect hypothesis is correct, my retrieval test will result in no differences between the performances of misled and control conditions.

The Retrieval Test

Responses to the event item. In the current experiment, I will have both control and misled subjects respond yes or no as to whether they had seen the event item. Table 1 illustrates a hypothetical situation of response patterns provided by control and misled subjects. Suppose that the usual number of total subjects who would remember the event information is 50%. Consider first the control condition in the upper portion of the table. Of the 50% who remember the initial event information, all of them (100%) would be correct. Of the remaining 50% who do not remember, 50% should correctly say yes by chance alone. In the control condition then, the overall percent of correct responses would be 75% (50% of subjects who remember + 25% (half of 50%) of subjects who do not remember).

[Insert Table 1 about here]

Consider now the misled condition in the bottom portion of Table 1. Focus on the 50% of misled subjects who, like subjects in the control condition, would ordinarily remember the event information. If postevent misinformation has no effect, all of these subjects, like control subjects, will be correct. On the other hand, if postevent information does have an effect, then many subjects (perhaps 50%) will be incorrect. Such subjects will have conflicting information as to which item was seen in the slides, and will reject the event item.

Special note, however, needs to be made regarding the 50% of misled subjects, who like their control counterparts, do not remember the event information for reasons other than being exposed to postevent misinformation. Although not remembering the event information, several of these subjects (perhaps 60%) will remember the postevent information. Faced with responding yes or no to having seen the event item which they do not remember, many subjects will incorrectly say no on the basis of believing the postevent information to be correct. The net result is that instead of 50% of the subjects in the misled condition guessing accurately as seen in the control condition, fewer than 50% of the misled subjects (let's say 20%) will be accurate. That is, of the misled subjects who do not remember the event information, 60% will remember the postevent information and all of these subjects will respond incorrectly. Half of the remaining 40% will respond correctly by chance.

Thus, even if postevent misinformation has no effect, subjects who are misled will be less accurate than control subjects (overall, 60% vs 75%). Of course, given that postevent information has an effect, the number of accurate responses from misled subjects will be lower yet (35%). We are left however with the quandary of determining whether the poorer performance of misled subjects is an artifact of the retrieval task in the same way that the retrieval task of Loftus et al. (1978) has been criticized by McCloskey and Zaragoza (1985a).

Responses to a novel item. Fortunately, there is a way out of the quandary. Table 2 introduces a hypothetical response pattern of control and misled subjects who are to respond yes or no to whether they had seen a novel item (correct response is no). With respect to the control condition, at this point I shall be brief. Assuming again that 50% of the subjects will remember the event item, the response pattern ought to be the same as seen from control subjects in Table 1.

[Insert Table 2 about here]

Of particular importance are the responses of misled subjects. The 50% of subjects who do remember the event item ought to be 100% correct in rejecting the novel item (assuming no influence of misleading postevent information toward making this decision). Of the remaining 50% of misled subjects (i.e., those who do not remember the event information), they should respond with a high percentage of correct rejections, a percentage above that of the 50% chance of the control group. To see why this is so, consider that such subjects may remember the postevent misinformation, and thus reject the novel item on the basis of being misled.

Further, among misled subjects who do not remember the event information, the increase of correct rejections responding no to a novel item (see Table 2) ought to be equivalent to the decrease of correct yes responses to the event item as seen in Table 1. The responses of these subjects in both conditions is essentially the same: saying no upon the retrieval test on the basis of believing the postevent misinformation to be correct. That is, given the arbitrary assumption that 60% of misled subjects remember the postevent information, all of these subjects (given that they do not remember the event information) will respond no to both event and novel items. Although all 60% will be incorrect when responding to the event item, all 60% will be correct when responding to the novel item. Half of the remaining 40% of misled subjects will be correct by chance whether responding to the event or novel item. The arithmetic leaves 80% (60% + 20%) of misled subjects to be correct in rejecting the novel item.

Thus, although the poorer performance of misled subjects in comparison to control subjects responding yes to the event item (see Table 1) is expected under circumstances in which postevent information has no effect (60% to 75%, respectively), an equivalent improvement in performance of misled subjects in comparison to control subjects is expected with responses of saying no to a novel item (see Table 2), likewise given no effect (90% to 75%, respectively). In order to assess any effect for misleading postevent information, a relatively simple critical comparison can be made. To the extent that the poorer performance of misled subjects in comparison to control subjects exposed to the event item during retrieval is greater than

the expected better performance of misled subjects in comparison to control subjects exposed to a novel item during retrieval, any effect for postevent misinformation can be determined. This critical comparison difference between control and misled performance is equivalent to collapsing scores across the type of test (event items vs novel items), and conducting an overall comparison between control and misled performance.

In addition, as Table 2 suggests, postevent misinformation may have an effect on recognition responses to a novel item. Subjects will have conflicting information in memory. The novel item presents a third reasonable alternative. Because of the conflict, subjects may conclude that their memory is unreliable and thus infer that the novel item was earlier seen. Of course, no effect is also quite possible as subjects may reject the novel item since it matches neither postevent nor event informations.

Sensitivity. As argued, the yes/no retrieval test of the current investigation is more sensitive to detecting potential influences of misleading postevent information than the two-alternative forced-choice retrieval test, as had been used by McCloskey and Zaragoza (1985a), because there is no comparison between alternatives with the yes/no test. However, the lacking of a comparison between alternatives with the yes/no procedure may also possibly result with the test being less sensitive to detecting the presence of event information that does reside in memory. Consider a situation in which memory for the event information is vague and imprecise. With the forced-choice test, the event item may yet be more familiar than the

novel item, and thus be consistently selected. On the other hand, with the yes/no procedure, the memory of the event information may not be strong enough to consistently affirm the event item, nor to consistently negate a novel item. Thus, under the same conditions, subjects who receive a yes/no test may provide fewer correct responses than subjects provided a forced-choice test. This potential lowered sensitivity with the yes/no test is problematical since the measured memory for event information may not be adequate to detect any potential influences of the misleading postevent information.

However, evidence suggests that the yes/no procedure is only slightly less sensitive than the forced-choice procedure in detecting memory for an experienced event. Graesser et al. (1980), for example, have found, with recognitions of verbal materials, that the yes/no test led to slightly reduced d' scores in comparison to the forced-choice test, but the difference in d' between tests was not statistically significant. Thus, the yes/no test ought to be adequately sensitive in measuring subjects' memories for the event information.

Response bias. Tables 1 and 2 have been derived with the assumption that when subjects do not remember the event nor postevent items, they have a 50% chance of being correct. However, there may be a response bias to say either yes or no systematically more often than 50%. There needs to be an accounting of three variables in order for a comparison of event items performance with novel items performance to be justified: 1) the proportion of subjects who remember at the time of retrieval the event information, 2) the proportion of misled

subjects who remember at the time of retrieval the postevent information, and 3) the proportion of subjects in addition (or subtraction) to 50% who will systematically respond 'yes' given that they remember neither the event nor postevent informations. Table 3 provides an algebraic proof that given no effects for postevent information, any values assigned to these three variables will result in the difference in correct recognitions between the control and misled conditions, tested by the event item, to equal the difference in correct recognitions between misled and control conditions that are tested by the novel item. Formulas in Table 3 assume an independence between the remembering of event information, and the remembering of the postevent information.

[Insert Table 3 about here]

In conclusion, my retrieval test is appropriate for examining whether postevent information influences the remembering of a past event. My retrieval test is an improvement over the test used by Loftus et al. (1978) as it does not bias misled performance to be worse than control performance under circumstances in which postevent information has no effect upon the remembering of event information. In addition, my retrieval test is an improvement over the modified test of McCloskey and Zaragoza (1985a), as it is more sensitive in detecting any potential effects that postevent information may have.

Implications for Eyewitness Testimony

In any research on human memory, there is always the difficulty of making inferences on the nature of memorial representations and processes on the basis of responses by participants in the laboratory. In the view of Loftus et al. (1985), there may be little to be gained by focusing attention on "representational issues;" rather, more can be learned by simply noting the relation between what is experienced (or presented) and what is reported. This suggestion by Loftus et al. has implications toward generalizing from postevent information studies to real world eyewitness testimony. Given that numerous studies have demonstrated the decrease of report accuracy due to the introduction of misleading postevent information, even if there is no clear indication that memories are altered by postevent information, exposure to misleading postevent information may reduce the accuracy of responses of real world eyewitnesses.

In reaction to the above-mentioned implication, McCloskey and Zaragoza (1985b) argue that "there is insufficient basis for assuming that the results of the available studies can be generalized to situations involving eyewitnesses" (p. 386). Their argument hinges on two points: 1) actual real world circumstances vary widely, and 2) even with the limited circumstances that have been varied in the laboratory, misleading information has not always led to a decrease in report accuracy. They conclude that generalizations from the laboratory to the real world can only be possibly accomplished by "an understanding of the cognitive mechanisms underlying the phenomenon in question and, hence, of what variables are relevant or irrelevant"

(p. 386-387).

I agree with McCloskey and Zaragoza (1985b) that a better understanding of the "cognitive mechanisms underlying the phenomenon in question" is crucial toward understanding whether generalizing from the laboratory to the real world is appropriate. And in this vein, the current investigation will contribute toward distinguishing the respective roles of two processes: 1) memory impairment, and 2) the decision to accept the misleading postevent information as correct given that the critical event information is not remembered.

There appears to be a tacitly accepted axiom that if misleading postevent information can be convincingly demonstrated to lead to impairment in memory, then there would be justification to conclude that real world eyewitnesses who are exposed to misleading postevent information will likely be influenced to alter their testimony. Certainly, in order to justify the inference that misleading postevent information does alter memory, at the very least there needs to be laboratory evidence that the responses of misled individuals are less accurate than individuals who are not misled. And generalizing from the laboratory to the real world, if misleading postevent information alters memory, then misled eyewitnesses will generally provide less accurate testimony than eyewitnesses who have not been misled. Although such a conclusion may be true when collapsing over all possible circumstances, it ignores crucial specific circumstances and the fact that being misled will influence the responses of those who do not remember the critical event information. In particular, by the term "specific circumstances," I am alluding to the responses of the

subjects that are likely to occur with the novel items test (see Table 2). In this test, it is quite unclear whether memory impairment (if any) will reduce the accuracy of responses, and very likely that for those who do not remember what was originally shown, that exposure to misleading postevent information will actually result in an improvement in accuracy in comparison to controls. Thus, even if there is convincing evidence that the introduction of misleading postevent information alters memory, there yet are likely to be special circumstances in which the introduction of misleading postevent information can improve response accuracy.

Increasingly, experimental psychologists are providing expert testimony on the (un)reliability of the responses of eyewitnesses (McCloskey & Zaragoza, 1985b). Some of this expert testimony involves assertions on the role that information acquired after an event may have on an eyewitness's memory. In fact, it may be true that the introduction of misleading postevent information does impair memory. Despite the existence of memory impairment, a demonstration that exposure to misleading postevent information under specific circumstances may lead to an improvement in response accuracy poses extreme difficulties for psychologists who become expert witnesses in particular cases. First, although any general statement that eyewitnesses will be biased toward providing incorrect testimony may be true, it is unwarranted, since such potential biases in testimony will not occur under certain circumstances. Second, in order to make responsible assertions concerning the probable report accuracy of an eyewitness, the relevant circumstances for the particular case in

question must be known in advance. Third, although in some cases such knowledge of relevant circumstances may be known in advance, for the most part, the particular circumstances of a case is what the court is seeking to determine.

Chapter Note

[1] There has been equivocal evidence regarding whether images undergo consistent size changes. Allport (1930), for example, discovered a "progressive shrinkage in the size of the image from one reproduction to the next" (p. 144, emphasis in the original), a finding in direct opposition to the increasing size of an image as reported by Warren and Shaw (1895). Other and more recent research has not consistently found evidence in support of size changes in either direction (Irwin & Seidenfeld, 1937; Riley, 1966). Warren and Shaw's study was highly influential on Kennedy's (1898) arguments that qualitative changes in memory needed to be explored; of historical interest is the understanding that Warren and Shaw's results were probably artifactual.

CHAPTER 11

THE EXPERIMENTAL INVESTIGATION

Method

Subjects

The subjects were 144 introductory psychology students who received course credit for their participation. There were 73 males and 71 females in the sample. They ranged in age from 18 to 23 years, with a mean age of 19.2 years.

Procedure

Subjects were tested in groups ranging in size from 5 to 23. Subjects at first were instructed that the experiment involved investigating whether visual or verbal modes of presentation lead to a better understanding of an event. There were three major phases to the overall procedure: viewing slides, reading a narrative concerning the slides, and taking the recognition test.

The slides. Subjects were shown a series of 73 color slides that depicted a maintenance man who steals \$20 and a calculator from an office. The slides consisted of a slightly reduced version of the same slides used by McCloskey and Zaragoza (1985a). The slide sequence included four critical slides, each of these slides depicting

one of four critical items. Each of the four critical slides depicted a critical item selected from four sets of slides, each set being composed of three critical items. One set of critical items depicts a coffee jar (Folgers, Maxwell House, Nescafe), a second set a magazine (Glamour, Vogue, Mademoiselle), a third set a soft drink can (7-up, Coke, Sunkist), and the fourth set a tool (hammer, screwdriver, wrench). Each critical item from each set was shown to one-third of the subjects. For example, one-third of subjects saw the Folgers jar, one-third saw the Maxwell House jar, and one-third saw the Nescafe jar. The sets always appeared in the slide presentation in the same sequence. A critical item from the set of coffee jars appeared as the 8th slide, a critical item from the set of magazines appeared as the 27th slide, the 58th slide depicted a critical item from the set of soft drink cans, and the 66th slide depicted a critical item from the set of tools.

The narrative. Following the slides, subjects read a detailed narrative concerning the event depicted in the slide presentation. The narrative was a slightly modified version of the same narrative that was used by McCloskey and Zaragoza (1985a). Before the narrative and immediately following the slides, subjects were engaged in a 10-minute filler activity that involved solving logic problems. Each subject received in the narrative misleading information concerning two of the critical items they had seen. The assignments of critical items and misleading information was counterbalanced across subjects. One-sixth of the subjects were provided misleading information for critical items from the first and second sets shown in the slides

(coffee jars and magazines), one-sixth for critical items from the first and third sets (coffee jars and soft drink cans), and so on. In this way, each set of critical items provided for one-half of subjects a control item, and for the other half served as a misled item. For control items, the narrative simply referred to the item generally. For example, subjects who were exposed to the Folgers jar in the slides read in the narrative a reference to the item as a coffee jar. With misled items, each of the two remaining critical items from a set which had not been shown in a particular slide sequence served for half of these subjects as misleading information. For example, when the Folgers jar was shown to subjects and used as a misled item, half of these subjects were misled in the narrative that they had seen a Maxwell House jar, and the other half were misled that they had seen a Nescafe jar.

After reading the narrative at their own pace, subjects returned to solving logic problems until a 10-minute interval had passed since the moment when the narrative had been initially introduced. The recognition test immediately followed the interval.

The recognition test. The recognition test consisted of 12 statements, with 8 of the statements being fillers. Subjects were instructed to respond to all statements solely on the basis of what they had seen in the slides. Each statement had an underlined word or phrase referring to an item. Subjects were instructed to respond 'yes' or 'no' as to whether the underlined item appeared in the slides. In addition, subjects provided a measure of the confidence in the accuracy of their responses on a scale in which 1 = complete

guess, 2 = unsure, 3 = somewhat sure, 4 = sure, and 5 = very sure. Half of the filler statements had underlined items that appeared in the slides, the other half referred to items that did not appear in the slides.

Four of the statements dealt with critical items. Two of these statements tested whether subjects remembered having seen a critical item that appeared in the slides (event items), the other two statements tested whether subjects remembered having seen a critical item that did not appear in the slides (novel items). The assignment of event and novel items to be recognized was counterbalanced with control and misled items and across subjects. Each subject had one of their control items tested by an event item, the other of their control items was tested by a novel item. Conversely, each subject had one of their misled items tested by an event item, the other misled item was tested by a novel item. Also, for those subjects, for example, who received misleading information concerning the first and second sets presented in the slides, for half of these subjects, the first set was tested by an event item (leaving the second set tested by a novel item), and for the other half, the first set was tested by a novel item. The same counterbalancing was maintained for control items and all sets. Further, with misled items that were tested by novel items, counterbalancing assured an equal use of the combinations from each set of a) the item that was shown in the slides, b) the item that was used as misleading postevent information, and c) the item that was used during the recognition test. For example, for subjects who were shown the Folgers jar, were later misled, and were tested by

a novel item, half were misled that they saw a Maxwell House jar and were asked upon retrieval whether they had seen a Nescafe jar, the other half were misled that they saw a Nescafe jar and were tested whether they saw a Maxwell House jar. Finally, with control items that were tested by novel items, each of the remaining critical items of a set which had not been shown in a particular slide sequence served as the novel item equally often. For example, when the Folgers jar was a control item and shown to subjects in the slides, half the time it was tested by Maxwell House, and the other times was tested by Nescafe.

Results and Discussion

Analyses were conducted using accuracy scores and combination scores. Accuracy scores consisted of the correct yes/no responses that subjects provided. Combination scores were computed using information from both accuracy scores and confidence measures, and ranged in value from 1 to 10 (for examples of the use of combination scores in postevent information studies, see Christiaansen & Ochalek, 1983; Loftus, 1979b). The combination scores of correct responses ranged in value from 6 to 10, and the combination scores for incorrect responses ranged from 1 to 5. Specifically, a combination score of 10 was assigned to a correct response that had received the high confidence rating of 5 (very sure); a correct response that was rated with a confidence of 4 was assigned a combination score of 9, and so on. Thus, with correct responses, higher combination scores reflected increases in confidence. With incorrect responses, lower combination scores were assigned to responses that were rated with higher

confidence. Specifically, a combination score of 1 was assigned to an incorrect response that received a confidence rating of 5, and so on.

Both accuracy and combination scores were the dependent variables of subjects analyses, in which subjects were treated as a random effect, and of items analyses, in which the items were treated as a random effect.

Subjects Analyses

The first subjects analysis conducted was performed on accuracy scores, and consisted of a comparison of control performance with misled performance. The experimental design required that each subject was tested on two items to which they were not misled (control items), and two items to which they did receive misleading postevent information (misled items). Thus, in each condition (control, misled), a subject may be accurate on neither of two recognitions, on one of two recognitions, or on both of two recognitions. The dependent variable consisted of the number of correct recognitions (0, 1, or 2) each subject provides to the control items and the misled items.

A correlated groups t-test was conducted on the accuracy measures comparing performance of the control condition ($M = 1.03$, $SD = 0.67$) with the misled condition ($M = 1.12$, $SD = 0.57$). The test was not significant, $t(143) = -1.34$, $p = .18$. Thus, misleading postevent information did not impair the accuracy of recognition for the critical items that were shown in the slides.

An analysis with the combination scores was also conducted. Unlike the analysis with accuracy scores, which only permits an overall comparison of control versus misled performance, it became possible with the combination scores to conduct a postevent information (PEI) condition (misled, control) X recognition test (TEST) condition (event items, novel items) repeated measures analysis of variance. Each subject contributed one combination score to each of the four conditions, and these combination scores served as the dependent measure.

Table 4 provides a summary of the PEI X TEST analysis of variance on the combination scores. First, as revealed by the analysis of the PEI main effects, a comparison of control performance ($M = 5.85$) with misled performance ($M = 5.98$) is not significant, $F(1, 143) = .32$, $p = .57$. Second, the PEI X TEST interaction effect is significant, $F(1, 143) = 76.83$, $p < .001$. Following the advice of Keppel (1982, p. 462), analyses of simple effects were conducted using error terms that were computed separately for each comparison (i.e., correlated groups t -tests). Analyses of simple effects reveal that when subjects were tested by event items, control performance (CE condition, $M = 5.88$, $SD = 2.69$) was significantly better than misled performance (ME condition, $M = 3.97$, $SD = 3.28$), $t(143) = 5.59$, $p < .001$. In addition, in conditions in which subjects were tested by novel items, control performance (CN condition, $M = 5.83$, $SD = 2.70$) was significantly poorer than misled performance (MN condition, $M = 7.99$, $SD = 2.65$), $t(143) = -7.31$, $p < .001$. A comparison of the responses of the CE and CN conditions did not reliably differ, $t(143) = 0.17$, p

= .86.

[Insert Table 4 about here.]

In summary, the influence of postevent information on item recognition is seen as a decrement in performance when subjects were asked to respond as to whether the original event items had appeared in the slides, but an improvement in performance when subjects' responses were directed toward items that were not shown in the slides. Thus, subjects were using the postevent information in making their decisions. These influences also account for the significant difference for the TEST condition (see Table 4).

Items Analyses

By use of an items analysis, a PEI condition X TEST condition repeated measures analysis of variance on accuracy scores was conducted. The dependent measure consisted of correct responses for each of the 12 items (the three critical items from the four sets) shown in the slides. Each subject contributed a response to one item in each of the four conditions. Each of the 12 items had a possible 12 correct recognitions per condition.

Table 5 provides a summary of this PEI X TEST analysis of variance on accuracy scores. The same pattern of results that was discovered with the subjects analysis of combination scores is revealed (see Table 4). Overall, control performance ($M = 6.17$) did not significantly differ from misled performance ($M = 6.75$), $F(1, 11) = 1.88$, $p = .20$. The PEI X TEST interaction effect is significant, $F(1, 11) = 28.32$, $p < .001$. The analyses of simple effects reveal that

the accuracy of the responses to items in the CE condition ($M = 5.58$, $SD = 2.31$) was significantly better than the accuracy scores in responses to ME condition items ($M = 3.42$, $SD = 2.81$), $t(11) = 4.57$, $p = .001$. Also, the accuracy scores of the CN condition ($M = 6.75$, $SD = 2.45$) were significantly worse in comparison to the MN condition ($M = 10.08$, $SD = 1.17$), $t(11) = -4.07$, $p = .002$. The accuracy of responses in the CE and CN conditions did not significantly differ, $t(11) = -1.06$, $p = .31$. Just as with combination scores, the number of accurate correct responses lessened with the introduction of misleading postevent information with tests of the original event items, whereas misleading postevent information resulted in accurate correct no responses to improve with tests of the novel items.

[Insert Table 5 about here]

An analysis of the accuracy scores permits an estimation of the percentage of responses that were based on the remembering of event information during the recognition test. Averaging across all conditions, 6.46 of a possible 12 (53.82%) responses were accurate. Assuming that 50% of all responses would be accurate by chance, 7.64% of the responses appear to have been based on the actual ability to remember the critical items in the slides ($.0764 + (.50 \times .9236) = .5382$). [1] This is a distressingly low rate of remembering, demonstrating that the subjects' abilities to discriminate between what was actually shown in the slides, and the distractor items, was extremely poor.

Individual items analyses. Such a poor ability at remembering what was actually seen may be a potential explanation for the failure at finding any effect for the misleading postevent information: there is little information in memory on which to mislead. An analysis of individual items was conducted in order to assess whether there were some items better remembered during recognition than other items, and if so, whether misleading information may have led to poorer performance for the better remembered items. The total number of accurate control responses was computed for each item. Also, added together was the mean of the 12 combination scores for each item in the CE condition with the mean of the CN condition. The 6 items that demonstrated the greatest number of accurate control responses and that also had the highest sum of the combination means were considered as the better remembered (BR) items, and were differentiated from the other 6 more poorly remembered (PR) items.

Table 6 lists the BR and PR items, the correct number of accuracy scores for each of the four conditions, and also the critical comparison difference (CCD, total of control condition performance minus total of misled condition performance) for each item. Means and standard deviations of accuracy scores, computed separately for the BR items and PR items, are also included in the table.

[Insert Table 6 about here]

An important caveat that must be addressed concerns whether the distinction between BR and PR items actually reflects a difference in the ability to remember the items. One possibility for the distinction could result from the BR and PR items being remembered

equally well (or equally poorly), only that when used as test items, the BR items were more successful at eliciting 'yes' responses than were the PR items. Among the control conditions, this possibility could explain the better performance of event items recognition with the BR items in comparison to the PR items ($\bar{M}_s = 6.17$ and 5.00 respectively, see Table 6), and since PR novel items were used as distractors more often in the test of BR items (and vice-versa), also explained would be the better performance with the BR items in the novel items test (BR $\bar{M} = 8.17$, PR $\bar{M} = 5.33$).

Clearly, there is no basis on which to make a reasonable decision on whether the better performance of BR items with event items tests is the result of the BR items being better remembered, or the BR items being simply more successful in eliciting 'yes' responses. On the other hand, an analysis of the responses to novel test items as distractors can differentiate whether to attribute the better performance with BR items to memory or response bias. That is, BR items will be shown to have been better remembered than PR items if the percentage of correct rejections in response to BR items is consistent whether tested with either BR or PR items, and the performance of correct rejections in response to PR items is consistent whether tested with either BR or PR items. In this situation the type of distractor, whether consisting of BR or PR items, does not matter; what does matter is whether BR or PR items were shown in the slides. Moreover, since better memory for the BR items resulted in better performance with the novel items test, we can generalize that better memory was also responsible for the better

performance of BR items in the event items test.

Table 7 lists the number and percentage of correct rejections in response to BR and PR items that were actually shown in the slides among all combinations of BR and PR items used as novel items distractors among the responses of the CN condition. As Table 7 illustrates, performance was dependent on which type of items were shown, whether BR or PR items, not on which type of items were used as distractors. As can be seen, when BR items were shown, both BR and PR test items were correctly rejected to an equivalent extent (70.83% and 66.67%, respectively), and that when PR items were shown, there was no appreciable difference in correctly rejecting BR or PR items (43.75% and 45.83%, respectively). In conclusion, the difference in discriminability between BR and PR items can be correctly attributed to BR items having been better remembered than the PR items.

[Insert Table 7 about here]

An exploration of the influence of misleading postevent information on both the better and poorer remembered items was conducted. As Table 6 illustrates, the critical comparison differences for accuracy scores with the BR items tend to be positive, suggesting that misleading postevent information did result in poorer performance. The pattern is in the opposite direction with the PR items; the critical comparison differences tend to be negative, suggesting that misleading postevent information improved performance for these items! A comparison of the critical comparison differences in accuracy scores between the BR items ($\bar{M} = 0.50$) and the PR items ($\bar{M} = -2.53$) is significant, $t(10) = 2.31$, $p < .05$. [2] Apparently,

misleading postevent information differentially influenced the accuracy scores in response to BR and PR items. Separate analyses were conducted for BR and PR items.

Analyses of BR items. A PEI condition X TEST condition repeated measures analysis of variance on accuracy scores was conducted. As Table 8 shows, the pattern of results for the BR items is the same as the analysis of variance on all of the items (see Table 5). Most importantly, there is no significant difference in the accuracy scores of the control condition ($M = 7.17$) in comparison to the misled condition ($M = 6.92$), $F(1, 5) = .18$, $p = .69$. There is a significant interaction effect, $F(1, 5) = 21.00$, $p < .01$. Analyses of simple effects reveal that the responses in the CE condition ($M = 6.17$, $SD = 2.48$) were significantly more accurate than the responses of the ME condition ($M = 4.17$, $SD = 3.13$), $t(5) = 3.85$, $p < .02$. Interestingly, although a comparison of the accuracy scores of the CN condition ($M = 8.17$, $SD = 2.14$) with the MN condition ($M = 9.67$, $SD = 0.52$) was directional with better performance demonstrated by the MN condition, the difference was not significant, $t(5) = -1.77$, $p = .14$. In addition, the performance of the CE and CN conditions did not significantly differ, $t(5) = -1.15$, $p = .30$.

[Insert Table 8 about here]

Although the overall effect for postevent information was nonsignificant, the analysis of simple effects suggests that the misleading postevent information may have resulted in a decrement in performance. Namely, whereas the misleading postevent information led to significantly poorer performance with the event items test, the

misleading postevent information did not lead to significantly better performance with the novels items test. A comparison of the effect sizes for these two tests, however, indicates that the misleading postevent information was influential to an equivalent extent with both types of test. Estimates of omega squared (ω^2) were computed as an indication of the effect sizes (for computation formulas, see Dodd & Schultz, 1973). The statistic ω^2 provides a ratio of the proportion of variance in accuracy scores that is accounted for by the influences of the various conditions (Hays, 1981; Keppel, 1982). For the events items test, the introduction of misleading postevent information resulted in $\omega^2 = .10$, and for the novels items test, $\omega^2 = .14$. [3] Thus, there is no indication for misleading postevent information leading to poorer performance.

Despite the failures so far, there is some suggestion of an influence for misleading postevent information, which arises from analyses of the number of 'yes' responses provided in the two conditions. The logic of these analyses rests on the assumption that if there was no remembering of the event information, there ought to be an equivalent number of 'yes' responses to the event items tests and novel items tests. On the other hand, if there was remembering for the event information, then 'yes' responses to the event items test will exceed 'yes' responses with the novel items test, demonstrating an ability to discriminate event from novel items.

In comparing 'yes' responses among the control conditions, the number of 'yes' responses with the CE condition ($M = 6.17$) did significantly exceed the number of 'yes' responses with the CN condition ($M = 3.83$) as revealed by a repeated measures t-test, $t(5) = 3.07$, $p = .03$. On the other hand, misled performance did not demonstrate an ability to discriminate event from novel items above chance level, as the number of 'yes' responses with ME condition ($M = 4.17$) did not significantly differ from that of the MN condition ($M = 2.33$), $t(5) = 1.36$, $p = .23$. In addition, effect sizes confirm that whereas control performance demonstrated an ability to discriminate, $\omega^2 = .18$, misled performance was poorer with discriminability $\omega^2 = .07$. Apparently, the misleading postevent information may have resulted in a poorer ability to discriminate event from novel items, suggesting that an impairment in memory did occur from its introduction.

Given that there is some suggestion of an influence for the misleading postevent information, the issue must be addressed as to the nonsignificant overall PEI effect. One possibility involves accepting the notion that the misleading postevent information actually did not have any effect, and that any difference in the discriminability between control and misled conditions (which is directional, but not significant) is attributable to sampling error. The other possibility suggests that there does exist a very small effect for misleading postevent information, and that the significance test lacked sufficient power to detect such a small effect. Any lacking of power can be traced to two factors. First, the sample size

of 6 items was small. Second, although the BR items were selected on the basis of their being better remembered, through an estimation based on overall performance over all of the conditions, only 17.36% of the responses were based on remembering the event information.[4] Perhaps if there was a greater overall ability to remember the event information, any influence of the misleading postevent information could have been detected.

Analyses of PR items. Table 9 provides a summary of a repeated measures PEI X TEST analysis of variance on accuracy scores. Most noteworthy is the significant main effect for the misleading postevent information, $F(1, 5) = 11.56$, $p = .02$, which demonstrates that control performance ($M = 5.17$) was poorer than misled performance ($M = 6.59$). This finding is in the opposite direction of expectation. Also of importance is the significant interaction effect, $F(1, 5) = 22.35$, $p < .01$.

Analyses of simple effects reveal that performance in the CE condition ($M = 5.00$, $SD = 2.19$) is significantly better than performance in the ME condition ($M = 2.67$, $SD = 2.50$), $t(5) = 2.77$, $p = .04$, $\omega^2 = .18$, and that performance in the CN condition ($M = 5.33$, $SD = 1.99$) is significantly worse than performance in the MN condition ($M = 10.50$, $SD = 1.52$) $t(5) = -5.46$, $p = .003$, $\omega^2 = .68$. Accuracy between the CE and CN conditions did not significantly differ, $t(5) = -0.23$, $p = .83$. As with the other analyses, the influence of misleading postevent information led to poorer accuracy with the event items test, and better accuracy with the novel items test. The significant effect for PEI is traceable to the improvement in accuracy

that results from postevent information with the novel items test to be greater than the decrement in accuracy with the event items test.

[Insert Table 9 about here]

The analyses seemingly suggest that the misleading postevent information led to an improvement in the ability to remember the event information. As this result is counterintuitive, additional analyses were performed. As with the BR items, tests for the control and misled conditions on the number of 'yes' responses were conducted, in order to assess the discriminability of the items.

An analysis of the control condition yielded results that were directional with respect to poorer than chance performance (CE \bar{M} = 5.00, CN \bar{M} = 6.67). This result is most troubling, as the only systematic possibility for poorer than chance performance would involve the novel items distractors being more attractive than the event items alternatives on the test. However, as demonstrated earlier (see above), there is no evidence that the distractors were more attractive than the event items in tests of PR items. Thus, there is no apparent reason for the control condition to perform worse than chance, and, in fact, the difference in 'yes' responses between CE and CN conditions is not significant, $t(5) = -1.81$, $p = .13$, $\omega^2 = .10$. The poorer than chance performance appears to be the result of sampling error.

In addition, if the better performance of accuracy with the misled condition could be attributed to an improvement in memory, then the misled condition ought to demonstrate memory for the event

information such that 'yes' responses for the ME condition exceed that of the MN condition. Although results are in this direction (ME \bar{M} = 2.67, MN \bar{M} = 1.50), the difference is not significant, $t(5) = 1.03$, $p = .35$, $\omega^2 = .00$. Thus, the significant effect for PEI cannot be attributed to memory performance.

Items analyses with the combination scores. Combination scores provide a more sensitive measure of memory than do accuracy scores, simply because they reflect the extent to which guessing may be involved in the response. Due to their greater sensitivity, separate items analyses on combination scores for the BR and PR items were deemed as appropriate.

Table 10 lists the mean combination scores of the conditions for BR and PR items. In addition, the critical comparison difference in combination scores are presented for each item, as well as means and standard deviations computed separately for BR and PR items.

[Insert Table 10 about here]

Similar to results with accuracy scores, the critical comparison differences in combination scores tend to be positive with BR items, suggesting that the introduction of misleading postevent information led to poorer remembering, whereas combination scores tend to be negative with PR items, suggesting that misleading postevent information improved remembering. The difference in the critical comparisons on the mean combination scores between the BR items (\bar{M} = 0.45) and the PR items (\bar{M} = -0.95) approached significance, $t(5) = 2.00$, $p = .06$.

As with the accuracy scores, PEI X TEST repeated measures analyses of variance were conducted separately on the mean combination scores for BR items and PR items. Table 11 provides a summary of the analysis for BR items. The same pattern of results that was revealed with the accuracy scores is demonstrated (see Table 8). Most noteworthy are two findings: the nonsignificant difference between control performance ($M = 6.41$) and misled performance ($M = 6.18$), $F(1, 5) = 0.78$, $p = .42$, and the significant PEI X TEST interaction effect, $F(1, 5) = 40.25$, $p = .001$. Analyses of simple effects reveal that CE performance ($M = 6.32$, $SD = 1.35$) is significantly better than ME performance ($M = 4.53$, $SD = 2.09$), $t(5) = 5.48$, $p < .01$; CN performance ($M = 6.49$, $SD = 0.72$) is significantly worse than MN performance ($M = 7.83$, $SD = 0.56$), $t(5) = -3.56$, $p = .02$; the performance of the CE and CN conditions did not reliably differ, $t(5) = -0.27$, $p = .80$.

[Insert Table 11 about here]

Just as with accuracy scores, there is the suggestion from direct analyses of the memory performance for the control and misled conditions that the misleading postevent information resulted in poorer memory for event information. To conduct these analyses, combination scores were computed such that 'yes' responses, regardless of their accuracy, were assigned the highest values for higher degrees of confidence (e.g., a 'yes' response with a confidence of 5 resulted in a combination score of 10), and that 'no' responses were assigned lower values for higher degrees of confidence (e.g., a 'no' response with a confidence of 5 resulted in a combination score of 1). If

there is memory for the event information, then the combination scores for the event items test will exceed the combination scores for the novel items test.

With control performance for the BR items, the scores of the CE condition ($\bar{M} = 6.32$) does significantly exceed those of the CN condition ($\bar{M} = 4.51$), $t(5) = 2.86$, $p = .04$, $\omega^2 = .38$. On the other hand, although the performance of the misled condition is directional with respect to remembering event information above chance expectation, the difference between the ME condition ($\bar{M} = 4.53$) and the MN condition ($\bar{M} = 3.17$) is not significant, $t(5) = 1.47$, $p = .20$, $\omega^2 = .10$. A comparison of the effect sizes suggests that the introduction of misleading postevent information resulted in a 28% reduction in the amount of variance in the combination scores accounted for by the type of test (i.e., event items test vs. novel items test). Although there is no significant main effect for PEI, the misleading postevent information may have resulted in a poorer ability to remember the event information.

Table 12 provides a summary of the analysis of variance conducted on the mean combination scores for the PR items. Unlike the analysis with accuracy scores (see Table 9), the main effect for PEI reveals that control performance ($\bar{M} = 5.31$) does not reliably differ from misled performance ($\bar{M} = 5.78$), $F(1, 5) = 4.83$, $p = .08$. Consistent with other analyses, there was a significant interaction effect, $F(1, 5) = 46.17$, $p = .001$, with the by now familiar pattern of results for simple effects. Namely, performance in the CE condition ($\bar{M} = 5.45$, $SD = 1.05$) is significantly better than that of the ME condition ($\bar{M} =$

3.41, $\underline{SD} = 1.36$), $\underline{t} (5) = 4.86$, $\underline{p} < .01$; the CN condition ($\underline{M} = 5.17$, $\underline{SD} = 0.85$) performed significantly more poorly than the MN condition ($\underline{M} = 8.15$, $\underline{SD} = 0.61$), $\underline{t} (5) = -6.85$, $\underline{p} = .001$; there is no significant difference between the CE and CN conditions, $\underline{t} (5) = 0.46$, $\underline{p} = .67$.

[Insert Table 12 about here]

In the direct analyses of memory performance for control and misled conditions, there was no evidence for memory of the event information as being different from chance expectation. The performance of the CE ($\underline{M} = 5.45$) and the CN conditions ($\underline{M} = 5.83$) revealed no differences, $\underline{t} (5) = -0.84$, $\underline{p} = .44$. Likewise, for the misled conditions, ME ($\underline{M} = 3.40$) and MN ($\underline{M} = 2.85$) conditions do not significantly differ, $\underline{t} (5) = 0.85$, $\underline{p} = .44$.

Chapter Notes

[1] Given that there was no overall effect for the misleading postevent information, in addition to estimating the percentage of responses based on remembering the event information, solving the equations presented in Table 3 will provide estimates of the percentages of responses that were made on the basis of remembering the misleading information, and on response bias when neither event information nor postevent information were remembered. In order to compute these estimates, the actual percentages of accuracy for each of the conditions needs to be adjusted, so that the equation $CE - ME = MN - CN$ is satisfied. Adding 2.43% to the actual percentages of the control conditions, and subtracting this same amount (2.43%) from the misled conditions satisfies the equation. The following table provides the values:

Condition	Actual Correct	Adjusted Correct
-----	-----	-----
CE	46.53%	48.96%
ME	28.47%	26.04%
CN	56.25%	58.68%
MN	84.03%	81.60%

Using the adjusted values and the formulas from Table 3, derived are $1-a = 7.64\%$, $1-b = 55.47\%$, and $c = -5.26\%$. That is, 7.64% of the responses are estimated to be based on remembering the event information. Of the remaining 92.36% of the total responses, for the control conditions, 44.47% of these responses were 'yes' responses, and 55.26% of these responses were 'no' responses; for the misled conditions, 55.47% of these responses were based on remembering the

postevent information, and believing the postevent information to be correct. For the misled conditions, of the remaining 41.13% of the total responses which were not based on either the event information nor the postevent information, 44.74% of these responses were 'yes' responses, and 55.26% of these responses were 'no' responses.

[2] In conducting the significance test, a between items analysis was used. The between items test is appropriate in consideration of the fact that BR items and PR items are mutually exclusive. However, the between items test may not have been appropriate in consideration of the fact that the same subjects were making responses to both BR and PR items. There were three series of slides shown, and for each series, the same subjects made responses to the four critical items that appeared. The following table lists the items shown in each of the three series of slides, and whether each of the items was a BR item or a PR item:

Set	Series 1	Series 2	Series 3
---	-----	-----	-----
coffee jar	Folgers (BR)	Maxwell-House (BR)	Nescafe (PR)
magazine	Glamour (BR)	Vogue (PR)	Mademoiselle (BR)
soft drink can	7-up (PR)	Coke (PR)	Sunkist (BR)
tool	hammer (BR)	screwdriver (PR)	wrench (PR)

Thus, the subjects who saw Series 1 made responses to three BR items, and one PR item; with Series 2 the subjects made responses to one BR item and three PR items; the subjects who were exposed to Series 3 made responses to two BR items and two PR items. Although the between items test may not have been appropriate, any other analysis would have been overwhelmingly complicated and cumbersome, especially since

the purpose of the test was simply to provide an indication of whether drawing a distinction between BR and PR items is justified.

[3] The omega squared statistics reported throughout the text have been computed from a formula that is based on the assumption that there is no treatment x items interaction. If the assumption is violated, a different formula for computing omega squared is required (Dodd & Schultz, 1973), which will result in an estimate that is the same or somewhat smaller than when the assumption is accepted. The omega squared statistics, as reported, are used only for illustrative purposes, and the same pattern of results occurs with either of the formulas.

[4] Just as with analyses of all of the items, in the significance tests of the BR items, there is no apparent overall influence for the misleading postevent information. Given no influence, just as has been done with all of the items, estimates of the percentages of responses based on 1) remembering the event information, 2) remembering the postevent information, and 3) response bias when neither the event information nor the postevent information is remembered, can be computed for the BR items solving for the equations in Table 3 (see Chapter Note 1). Actual and adjusted percentages of correct responses for the conditions are reported in the following table; the adjusted percentages satisfy the equation $CE - ME = MN - CN$.

Condition	Actual Correct	Adjusted Correct
-----	-----	-----
CE	51.39%	50.34%
ME	34.73%	35.77%
CN	68.06%	67.02%

MN	80.56%	81.59%
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From the formulas of Table 3, solving equations results in $1-a = 17.36\%$, $1-b = 44.18\%$, and $c = -10.09\%$. That is, 17.36% of the responses are estimated to be based on remembering the event information. Of the remaining 82.64% of the total responses, for the control conditions, 39.91% of these responses were 'yes,' and 60.09% were 'no;' for the misled conditions, 44.18% of these responses were based on the postevent information being remembered and believed as correct. For the misled condition, of the remaining 46.12% of the responses that were not based on either the event information nor the postevent information, 'yes' responses accounted for 39.91%, and 'no' responses accounted for 60.09%.

CHAPTER III

CONCLUSIONS

The aim of this investigation has been twofold: 1) to determine whether the introduction of misleading postevent information influences, at the level of memory representations, the ability to remember what was originally seen in an event, and 2) to clarify the implications of postevent information studies upon an understanding of real world eyewitness testimony. There is no doubt that the misleading information influenced the responses of subjects: the responses in the misled condition were less often correct on the event items test, and more often correct on the novel items test, in comparison to the control condition. However, overall, misled performance was as accurate as control performance. Thus, the current investigation provides no firm evidence that misleading information alters the representation of an experienced event. Also, since responses of the misled conditions were either less or more accurate than the responses of the control condition, the current investigation suggests that no general conclusion can be drawn as to how the response accuracy of real world eyewitnesses will be influenced by information that is encountered after witnessing an event.

The Memory Impairment Issue

In seeking to draw some conclusion from the current investigation with respect to the memory impairment issue, an important aspect of the results that deserves initial consideration has been the overall poor memory for the original critical items shown in the slides. As Zaragoza, McCloskey, and Jamis (1987) have recently noted, poor memory for event information may be either a strength or weakness for postevent information studies:

On the one hand, original information might be especially vulnerable to memory-impairing effects of misleading information when...the original information is difficult to remember even in the absence of misinformation. On the other hand, if few subjects are able to remember the original information even before misleading information is presented, there are few subjects whose memories can potentially be impaired by the misinformation. (p. 39)

Between these two alternatives, the current results strongly indicate that a fairer test of memory impairment will occur when there is good memory rather than poor memory for the event information. Only with the better remembered items was there any suggestion for memory impairment as a result of the introduction of postevent information. With the more poorly remembered items, if anything, the postevent information led to memory improvement!

Even with consideration only for those responses obtained for the better remembered items, there may not have been a sufficiently large percentage of subjects who remembered the event information to provide a robust enough test for detecting any potential influence of misleading postevent information. Not only was the estimated percentage of responses based on remembering the event information relatively low (17%), but also the test was conducted on the responses to only a few critical items (6). Even so, there was some suggestion that memory for event information was better with the control condition than the misled condition; perhaps an overall significant finding for the misleading information may have been the result if there was better memory for the event information.

Given that the lack of an adequate memory for the event information has shown itself to be an important issue with the interpretation of results, discussion of the potential factors leading to poor memory is in order. The procedure of the current study was basically the same as the one used by McCloskey and Zaragoza (1985a, Experiment 1): the same critical slides were shown for the same amount of duration, and almost verbatim narratives in which postevent information was introduced were used. Yet, whereas control performance in McCloskey and Zaragoza yielded a 69% rate of accuracy, the overall performance in the current investigation only yielded 54% accurate responses.

There were some differences between the two studies. Three of them are particularly promising as factors that could have led to poorer performance in the current investigation: 1) The orienting instructions were slightly different. McCloskey and Zaragoza instructed subjects that "the experiment concerned intuitions about memory" (p. 6), whereas in the present study subjects were told that the experiment was concerned with the understanding of events. Perhaps referring to memory in the instructions led subjects to pay closer attention to the detail presented in the slides. It must be pointed out, however, that instructions for both studies encouraged subjects to pay close attention to the slides. 2) The filler exercises were different. The filler exercises used by McCloskey and Zaragoza were not specified. In the present study, subjects were asked to solve logic puzzles. A number of subjects freely reported (in required written reports) that the puzzles were demanding and difficult. Perhaps the effort expended on the puzzles led to rapid forgetting of the information in the slides. 3) The memory test was different. Of course, the major purpose of the current study was to see if memory impairment in the face of misleading postevent information could be demonstrated with the use of a yes/no recognition procedure, since no memory impairment was demonstrated with the two-alternative forced-choice test used by McCloskey and Zaragoza. As discussed earlier, the yes/no test was seen to be potentially less sensitive to detecting event information that does reside in memory in comparison to the forced-choice test. Unforeseen was that the yes/no test may have been far less sensitive.

Of these possibilities, the last one, concerning the retrieval test, is most relevant with respect to the issue of how best to detect potential memory impairment resulting from the introduction of misleading postevent information. Perhaps in order to obtain the same percentage of correct responses with both the yes/no and the forced-choice tests, the memory for event information may have to be stronger with the yes/no test. Having a strong memory for the event information leads to an obvious difficulty with respect to testing the memory impairment hypothesis. There has been evidence that memory for the event can be too distinct in the sense that misleading information is considered blatantly false, and thus rejected (e.g., Loftus, 1979b). Therefore, although the current evidence suggests that memory impairment will be more robustly tested in a situation whereby the control condition demonstrates having a good memory for the critical slides, there is the danger that the memory of participants may be too good. It is quite unclear whether there exists a balance in which there is ample memory on which to measure and mislead, and yet a memory not so strong as to prevent misleading information from having any effect.

Implications for Eyewitness Testimony

As discussed earlier, there is the issue of whether the response accuracy of real world eyewitnesses can be justifiably stated to be influenced by information encountered after an event. As argued, this issue can only be ascertained by understanding how the responses of laboratory participants are determined by 1) the underlying cognitive processes, and 2) relevant variables (McCloskey & Zaragoza, 1985b).

In the current investigation, the cognitive process that appears to account for the greatest portion of the responses of participants, with respect to the influence of misleading postevent information, is the decision making that occurred when the event information was not remembered. In particular, exposure to the postevent information provided the opportunity for the remembering of this misleading information, and its acceptance as being correct. In addition, an extremely important variable is type of test. With the event items test, the introduction of misleading postevent information decreased response accuracy; with the novel items test, exposure to misleading postevent information increased accuracy.

In all previous postevent information studies, exposure to misleading postevent information has either been shown to decrease response accuracy (e.g., Loftus et al., 1978), or to have no influence on response accuracy (e.g., McCloskey & Zaragoza, 1985a). Given these findings, Loftus et al. (1985) have suggested that when there is an influence for misleading postevent information, the influence is such as to reduce response accuracy. As reviewed earlier, McCloskey and Zaragoza (1985b) have amply criticized any suggestion that warrants the propriety of a psychologist, acting as an expert witness, to offer testimony that the response accuracy of eyewitnesses will generally be reduced by information introduced after witnessing an event. The current investigation has provided additional evidence to the effect that an expert witness is unjustified in making such a claim--exposure to misleading postevent information can also increase response accuracy.

There may be objections on the basis that the special laboratory circumstances that have led to an improvement in response accuracy are not likely to occur in the real world. As McCloskey and Zaragoza (1985a) point out, however, the variation in circumstances in the real world are probably much greater than the number of variables that have at this date been manipulated in the laboratory. In addition, with a little thought, numerous scenarios of the response accuracy of eyewitnesses becoming improved because of some exposure to information after an event can readily be imagined.

The current investigation highlights the point that for a psychologist to be justified in making statements on the influence of postevent information on the responses of eyewitnesses in actual cases, the expert testimony must be based on advance knowledge of the particular circumstances. In most cases, however, it is these relevant circumstances that the court is obligated to discover. Thus, with respect to our current state of knowledge, expert testimony appears of limited value.

Table 1

Hypothetical Response Pattern of Saying Yes to Event Item

Memory state for original event information	% of subjects in memory state	Expected performance on saying yes to event item
Control Condition		
Remember	50%	100% correct
Do not remember	50%	50% correct
Total percentage correct		75% (50% + 25%)
Misled Condition		
Remember	50%	no effect 100% correct effect 50% correct
Do not remember	50%	20% correct
Total percentage correct		no effect 60% (50% + 10%) effect 35% (25% + 10%)

Table 2

Hypothetical Response Pattern of Saying No to Novel Item

Memory state for original event information	% of subjects in memory state	Expected performance on saying no to novel item
<hr/>		
Control Condition		
Remember	50%	100% correct
Do not remember	50%	50% correct
Total percentage correct		75% (50% + 25%)
<hr/>		
Misled Condition		
Remember	50%	no effect 100% correct effect 50% correct
Do not remember	50%	80% correct
Total percentage correct		no effect 90% (50% + 40%) effect 65% (25% + 40%)
<hr/>		

Table 3

Algebraic Proof that any Values can be Assigned Without Affecting
Critical Comparison

Terms

1-a = % who remember event information
 a = % who do not remember event information
 1-b = % who remember misleading postevent information
 b = % who do not remember misleading postevent information
 c = % in addition to 50% chance level who will respond 'yes'

Formulas

Control x Event Item Condition (CE)
 % correct = 1-a + (.5+c) (a)
 = ac - .5a + 1

Misled x Event Item Condition (ME)
 % correct = 1-a + (.5+c) (b) (a)
 = abc + .5ab - a + 1

Control x Novel Item Condition (CN)
 % correct = 1-a + (.5-c) (a)
 = -ac - .5a + 1

Misled x Novel Item Condition (MN)
 % correct = 1-a + (1-b) (a) + (.5-c) (b) (a)
 = -abc - .5ab + 1

Proof

CE - ME = -abc - .5ab + ac + .5a
 MN - CN = -abc - .5ab + ac + .5a

Table 4

Summary of PEI X TEST Subjects Analysis of Variance on the Combination Scores

Source	df	SS	MS	F	p
Main Effect					
PEI	1	2.25	2.25	.32	.57
Error	143	997.25	6.97		
Main Effect					
TEST	1	568.03	568.03	58.00	< .001
Error	143	1400.47	9.79		
Interaction Effect					
PEI X TEST	1	600.25	600.25	76.83	< .001
Error	143	1117.25	7.81		

Table 5

Summary of PEI X TEST Items Analysis of Variance on the Accuracy Scores

Source	df	SS	MS	F	p
Main Effect					
PEI	1	4.08	4.08	1.88	.20
Error	11	23.92	2.17		
Main Effect					
TEST	1	184.08	184.08	20.47	.001
Error	11	98.92	8.99		
Interaction Effect					
PEI X TEST	1	90.75	90.75	28.32	< .001
Error	11	35.25	3.20		

Table 6

The Correct Number of Accuracy Scores for Better Remembered and Poorly Remembered Items

Better Remembered Items					
Item	CE	CN	ME	MN	CCD
hammer	10	7	9	10	-2
Glamour	6	10	4	10	2
Folgers	7	7	4	10	0
Mademoiselle	4	10	0	9	5
Sunkist	3	10	2	10	1
Maxwell-House	7	5	6	9	-3
Mean	6.17	8.17	4.17	9.67	0.50
Standard Deviation	2.48	2.14	3.13	0.52	2.88
Poorly Remembered Items					
Item	CE	CN	ME	MN	CCD
7-up	4	8	4	11	-3
Coke	5	7	2	12	-2
wrench	8	3	7	10	-6
screwdriver	7	4	1	12	-2
Vogue	4	6	2	8	0
Nescafe	2	4	0	10	-4
Mean	5.00	5.33	2.67	10.50	-2.83
Standard Deviation	2.19	1.97	2.50	1.52	2.04

Table 7

Number and Percentages of Correct Rejections in Response to BR and PR Items Shown in the Event and BR and PR Items Used as Novel Items Test Distractors for the CN Condition

BR Items Shown and BR Items as Test Item Distractors			
Shown Item	Test Item	Ratio	% Correct Rejections
Glamour	Mademoiselle	5/6	83.33%
Mademoiselle	Glamour	5/6	83.33%
Folgers	Maxwell-House	4/6	66.67%
Maxwell-House	Folgers	3/6	50.00%
Totals		17/24	70.83%
BR Items Shown and PR Items as Test Item Distractors			
Shown Item	Test Item	Ratio	% Correct Rejections
hammer	wrench	3/6	50.00%
hammer	screwdriver	4/6	66.67%
Glamour	Vogue	5/6	83.33%
Mademoiselle	Vogue	5/6	83.33%
Sunkist	7-up	5/6	83.33%
Sunkist	Coke	5/6	83.33%
Folgers	Nescafe	3/6	50.00%
Maxwell-House	Nescafe	2/6	33.33%
Totals		32/48	66.67%

Table 7 continued on next page

Table 7 continued

PR Items Shown and BR Items as Test Item Distractors			
Shown Item	Test Item	Ratio	% Correct Rejections
wrench	hammer	1/6	16.67%
screwdriver	hammer	3/6	50.00%
Vogue	Glamour	3/6	50.00%
Vogue	Mademoiselle	3/6	50.00%
7-up	Sunkist	3/6	50.00%
Coke	Sunkist	4/6	66.67%
Nescafe	Folgers	2/6	33.33%
Nescafe	Maxwell-House	2/6	33.33%
Totals		21/48	43.75%

PR Items Shown and PR Items as Test Item Distractors			
Shown Item	Test Item	Ratio	% Correct Rejections
wrench	screwdriver	2/6	33.33%
screwdriver	wrench	1/6	16.67%
7-up	Coke	5/6	83.33%
Coke	7-up	3/6	50.00%
Totals		11/24	45.83%

Table 8

Summary of PEI X TEST Analysis of Variance on the Accuracy Scores with
Better Remembered items

Source	df	SS	MS	F	p
Main Effect					
PEI	1	.38	.38	.18	.69
Error	5	10.38	2.08		
Main Effect					
TEST	1	84.38	84.38	6.66	.05
Error	5	63.38	12.68		
Interaction Effect					
PEI X TEST	1	18.38	18.38	21.00	< .01
Error	5	4.38	.88		

Table 9

Summary of PEI X TEST Analysis of Variance on the Accuracy Scores with Poorly Remembered Items

Source	df	SS	MS	F	p
Main Effect					
PEI	1	12.04	12.04	11.56	.02
Error	5	5.21	1.04		
Main Effect					
TEST	1	100.04	100.04	14.21	.02
Error	5	35.21	7.04		
Interaction Effect					
PEI X TEST	1	84.38	84.38	22.35	< .01
Error	5	18.88	3.78		

Table 10

The Mean Combination Scores for Better Remembered and Poorly Remembered Items

Better Remembered Items					
Item	CE	CN	ME	MN	CCD
hammer	8.50	7.33	7.83	7.83	0.17
Glamour	6.08	6.67	4.58	8.75	-0.58
Folgers	6.42	5.83	4.92	7.92	-0.59
Mademoiselle	4.67	6.75	1.58	7.83	2.01
Sunkist	5.25	6.92	3.17	7.00	2.00
Maxwell-House	7.00	5.42	5.08	7.67	-0.33
Mean	6.32	6.49	4.53	7.83	0.45
Standard Deviation	1.35	0.72	2.09	0.56	1.24
Poorly Remembered Items					
Item	CE	CN	ME	MN	CCD
7-up	5.42	6.00	4.42	8.67	-1.67
Coke	5.17	6.08	2.92	8.08	0.25
wrench	6.92	4.42	5.58	8.25	-2.49
screwdriver	6.33	4.50	2.42	8.92	-0.51
Vogue	4.83	5.58	3.17	7.25	-0.01
Nescafe	4.00	4.42	1.92	7.75	-1.25
Mean	5.45	5.17	3.41	8.15	-0.95
Standard Deviation	1.05	0.81	1.36	0.61	1.05

Table 11

Summary of PEI X TEST Analysis of Variance on the Mean Combination Scores with Better Remembered Items

Source	df	SS	MS	F	p
Main Effect					
PEI	1	.30	.30	.78	.42
Error	5	1.91	.38		
Main Effect					
TEST	1	18.09	18.09	6.22	.06
Error	5	14.53	2.91		
Interaction Effect					
PEI X TEST	1	14.78	14.78	40.25	.001
Error	5	1.84	.37		

Table 12

Summary of PEI X TEST Analysis of Variance on the Mean Combination Scores with Poorly Remembered Items

Source	df	SS	MS	F	p
Main Effect					
PEI	1	1.34	1.34	4.83	.08
Error	5	1.39	.28		
Main Effect					
TEST	1	30.00	30.00	24.40	< .01
Error	5	6.15	1.23		
Interaction Effect					
PEI X TEST	1	37.92	37.92	46.17	.001
Error	5	4.11	.82		

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